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REPORT OF THE COMMITTEE APPOINTED BY THE COUNCIL TO CONSIDER THE QUESTION OF THE CLOSURE OF THE MORAY FIRTH TO TRAWLING

EN COMMISSION CHEZ
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COPENHAGUE – IMPRIMERIE BIANCO LUNO

International Council for the Exploration of the Sea.

Report of the Committee appointed by the Council to consider the question of the Closure of the Moray Firth to Trawling.

Preliminary Remarks and Terms of Reference.

In September 1925 the International Council at the request of the British delegates set up a special Committee to consider the question of the closure of the Moray Firth to trawling, consisting of the undermentioned members, viz.:—

Professor J. Hjort, Chairman	Norway,
Dr. Schmidt	Denmark,
Dr. Redeke	Holland,
Professor Gilson	Belgium,
Dr. Russell	England,
Dr. Bowman	Scotland.

At the meeting of the Council in September 1926, the Committee was reconstituted as follows:—

Professor J. Hjort, Chairman	Norway,
Professor Schmidt	Denmark,
Professor Ehrenbaum	Germany,
Professor Gilson	Belgium,
M. Léon Verbrugghe	Belgium,
Dr. Russell	England,
Dr. Bowman	Scotland.

After full consideration the terms of reference to the Committee were arranged as follows:—

"To inquire as to the effects of trawling in the Moray Firth in the light of the scientific investigations already carried out or of any further investigations which the Committee may deem necessary, or of any other relevant considerations, and to consider particularly whether it is desirable to continue the existing prohibition of trawling there and whether the prohibition in its present

or any modified form should be applied to any other method of fishing and to fishing vessels of all nationalities in the whole or any part of the extra-territorial waters of the Firth".

Professor HJORT, Dr. RUSSELL and Dr. BOWMAN have visited the Moray Firth and through the courtesy of Mr. JONES, Chairman of the Fishery Board for Scotland, they were placed in possession of all available facts and details relating to the question. The information is presented in detail in the accompanying papers contributed by Dr. BOWMAN and members of the Scientific Staff and by Mr. H. J. CROWE of the Fishery Board for Scotland, the latter of whom acted as Secretary to the Committee.

Meetings of the full Committee were held at Ostend on the 4th and 5th of April 1927, and were also attended by Dr. J. J. TESCH, who at Professor HJORT's request kindly agreed to serve on the Committee as the representative of the Netherlands. The appended papers were laid before the Committee together with a draft Report which had been prepared by the members who visited the Moray Firth. After full discussion the Committee agreed upon the following Report, in which for convenience the more important details relating to the question are briefly summarised.

SECTION I.

Object of Closure.

The closure of extra-territorial waters in the Moray Firth dates back to 1890 and was introduced in furtherance of a legislative policy for the restriction of trawling at a time when trawling was developing rapidly and spreading northwards and was giving rise to apprehensions as to the rapid depletion of fishing grounds. Trawling had already been prohibited by statute in Scottish territorial waters and also in certain other waters including the whole of the Firth of Clyde.

Special Characteristics of Moray Firth.

The Moray Firth as bounded seaward by the imaginary line from Duncansby Head to Rattray Head is an area roughly triangular in shape comprising approximately 2,020 geographical square miles of which about 1,517 square miles lie outside the British territorial three-mile limit.

The Moray Firth contains a fair abundance of the same economic species of food fishes as are found in the rest of the North-Western North Sea. Its configuration is such that it provides at nearly all seasons of the year sheltered areas in which fishing by small boats can be carried on safely and with a minimum of interruption; and in this respect it presents advantages for the prosecution of local

fisheries not enjoyed to the same degree on open stretches of coast. This circumstance favoured the early rise of the numerous fishing communities along its shores and the development of the local fisheries; and the question of the conservation of these local fisheries necessarily came into special prominence with the development of trawling and other modern methods of intensive fishing.

Local Fishing Activities.

The energies of the fishermen of the Firth have in the past been mainly directed to herring fishing and line fishing. In early years, when small sailing and rowing boats only were in use, the herring fishings were much more local and restricted than they are at present and the line fishings were pursued with greater activity by larger numbers of the fishermen for longer periods of the year than at present.

The line fishings of the Firth came prominently to the fore in the early days of the development of trawling, and the special measures taken in 1890 and 1892 with a view to their protection were an important feature of the controversy between trawling and lining interests. In those years the British Government by means of byelaws sought to exclude all trawlers from operating firstly within part and later within the whole of the Firth, but although the byelaws have been maintained against British trawlers, it was decided after a certain period not to apply them to trawlers of other nationalities which have continued to fish in the Firth in varying numbers and, with the exception of the War years 1915—1918, consistently from year to year. (See Statement No. 2, Paper No. 1, page 22).

Changes in Fishing Fleets and in Methods of Fishing.

This state of affairs has continued to the present time but during the period the activities of the local fishermen have undergone important changes. The steam drifter, introduced in 1895, and the motor drifter, introduced in the Moray Firth in 1909, have been adopted very extensively and have greatly extended the sphere of the herring fisheries and the period during which they are carried on. These fisheries, which are the main source of livelihood for the population of the Firth, are followed by the more active and energetic men during the greater part of the year (in some cases 8 or 9 months) from the principal herring fishing centres round the British coasts, and the time which these fishermen are able to devote to line and other fishings in the Firth is therefore necessarily restricted. The fishing in which the greatest number of Moray Firth men is engaged is the Great Summer Herring Fishery. The alternative local fisheries are therefore carried on by the main body of fishermen only at intervals between the herring fishings, but they are also carried on more or less all the year round by the older men who have retired from deep sea fishing and the boys. It is worthy of remark that they

afford a valuable means of training for many of those from whom the herring fishing crews are recruited and a suitable line of employment for the older men.

The increased attention given to the herring fishings as a result of the use of the steam and motor drifters is reflected in the statistics of the line fishings of the Firth which on the whole show a great decline after 1896. (See Statement No. 13, Paper No. 1, page 33). At the same time, however, the use of motor-boats has extended the range of the line fishermen and represents another important change in the local conditions.

Of recent years two important new methods of fishing have been adopted by the local fishermen, viz., anchored cod-net fishing, which commenced in the Firth in season 1906, and Danish seine-net fishing, which was introduced in September 1921. These methods are dealt with particularly in Paper No. 8 and Paper No. 9 respectively.

SECTION II.

Short Review of Present-Day Methods of Fishing.

The principal methods of fishing employed in the Moray Firth at the present time are by means of small lines, hand lines, cod-net, seine-net, flounder-net, drift-net, and trawl.

(1) **Small Lines.** Fishing by small lines is the most important of the local fisheries of the Moray Firth and is engaged in by some fishermen all the year round and by others only in the intervals between the herring fishings. The method is prosecuted mainly from the south shore of the Firth, principally the Banff district. It is carried on over a great part of the Firth but mainly within the 30 fathom line of depth, including also the important area of Smith Bank (see Chart of Fishing Grounds, Paper No. 7, page 87).

The haddock is the mainstay of this fishery, representing approximately 70 per cent. of the catch, as against a percentage of under 6 for the plaice (see Paper No. 7, page 112).

The lines are shot mainly in daylight or just before dawn; the fishermen stay by them and haul them not long after shooting. Collisions with other gear, though they occasionally occur, are almost negligible under existing conditions. The lines may sometimes be used on hard ground which is not suitable for trawling operations and they may extend to 2500 fathoms in length.

(2) **Hand Lines.** Fishing by hand lines is at the present time comparatively unimportant and is prosecuted with greatest vigour in the Wick district. It is carried on largely in inshore waters.

(3) **Cod Nets.** The cod-net fishing, which plays an important part in the routine of the local fisheries, is confined to the first four months of the year and takes place mainly in that area of the Firth which lies to the west of longitude

2°50′ W. East of that line, the fishing is prosecuted chiefly by small boats within five miles off the South coast.

The fleet employed consists of steamers and large and small motor and sail boats, of which the higher-powered vessels and the few remaining large sail boats operate mainly from Buckie (see Paper No. 8, page 162). The catch consists almost exclusively of large mature cod which come into the Firth for spawning.

The cod-nets are sometimes little more than a quarter of a mile apart and since as many as 225 boats have been employed at a time and as the larger boats carry from 40 to 50 nets, each of which when mounted extends to 60 yards in length, a great concentration of gear takes place on the fishing grounds. The fishermen do not stand by their nets but, having set them, return to port, revisiting the nets at the first favourable opportunity which may, however, in bad weather not occur for several days. The nets are not lighted at night, the fishermen stating that lighting is not practicable. It is impossible for trawlers working in the same area at night always to avoid collision with the cod-net gear and much loss has been caused to the local fishermen (see Paper No. 1, page 16). Of recent years the fishing has fallen off but the fishermen state that, if the fear of damage by trawlers were removed, they would prosecute the fishing more vigorously.

(4) **Danish Seine Nets.** Danish seine net fishing is a recent innovation in the Moray Firth, having been introduced in September 1921. It is prosecuted mainly from ports along the south coast and from Fraserburgh and Aberdeen, the most intensive fishing occurring during the months January to April. Some vessels continue the fishing in the Firth throughout the whole year, while others either go to the herring fishings or prosecute the Danish seine net fishing on the Dogger Bank and other areas outwith the Firth.

Two types of nets are used, the plaice and haddock seine. Plaice, lemon-sole, and cod are the most important species caught in the spring months, while witches and haddock also contribute substantially to the catches during this period. Haddock and sometimes hake become relatively more prominent in the catches during the rest of the year.

As fishing with the Danish seine net is carried on mainly in daylight, collisions with other gear are practically negligible under present conditions.

Danish seine net fishing is prohibited in the exclusive fishery limits of the Moray Firth.

(5) **Flounder Nets.** Fishing by anchored flounder nets was formerly carried on in inshore waters off the coast of Banff from January to March, but the fishing was relatively unimportant and has been practically abandoned in recent years.

(6) **Drift Nets.** As already stated, since the introduction of steam and motor drifters drift net fishing for herrings has assumed much greater relative importance for the majority of the Moray Firth fishermen and must therefore be noted with reference to the question now under consideration. Fishing for herrings by means

of drift nets is prosecuted in the north-west and outer portions of the Moray Firth generally in the months of August and September as part of the great summer herring fishery.

(7) **Trawling.** (See Paper No. 10, page 217). Trawling by vessels of non-British nationality is prosecuted in the Firth throughout the whole year but is most intensive in the months January to April and in the area west of 2°50′ W. The landing of the catches, which consist principally of spawning cod and plaice, is not permitted at British ports. British trawlers are under present conditions excluded from operating in the Firth.

Collisions between trawlers and the cod-net gear are dealt with elsewhere (See Section IV of this Report).

SECTION III.

Natural History of the Principal Species of Fish and Methods of Capture Employed.

The species of fish caught in the Moray Firth are the same as those caught in adjacent areas. The Firth is an area which has no barriers to the immigration or emigration of those species caught within its boundaries.

The demersal species of greatest economic importance to the fisheries of the Firth are haddock, cod and plaice, and the points of importance in the life histories of these species are briefly summarised.

Plaice.

A. Natural History.

The Moray Firth is the most important spawning area for the plaice of the East Coast of Scotland for here are found by far the largest numbers of ripe fish and the highest frequency of newly spawned and developing pelagic plaice eggs. In the winter months just prior to spawning there is a concentration of the maturing plaice in the inner and shallower waters of the Firth. Marking experiments have shown that the immigration from areas outside the Firth by fish which have reached the age of maturity is most pronounced at this period. The spawning period extends from mid-December to April, the most intensive period being February—March. The spawning fish are found outside the 20-fathom contour line of depth and the main spawning grounds lie west of Longitude 2°50′ West. The eggs and larvae are distributed by the prevailing currents and later populate the shallow coastal waters of the Moray Firth and East Coast of Scotland. The bathymetric conditions of the Moray Firth are such that the young plaice of less than two years old are found only inside a narrow coastal zone. As the fish grow older they spread offshore, the

larger sizes being found in greater depths. A few of these larger fish may leave the Firth and spawn later in areas beyond its limits. As a rule emigration is northwards and westwards; it is rare for a plaice to migrate from the Firth in a southerly direction. There is a seasonal concentration of the mature fish on the spawning grounds. Many maturing fish from beyond the limits of the Firth — especially from the coastal waters of the East Coast of Scotland to the south of Rattray Head — also participate in this spawning concentration.

B. Plaice Fisheries.

It is only since the introduction of the method of fishing by Danish Seine Net that any considerable number of plaice has been caught by local fishermen. The quantities of plaice caught by small lines, cod nets and flounder nets have always been relatively negligible. Fishing for plaice by small lines is restricted to a few of the sandy bays where the local fishermen fish chiefly with lug bait from small boats mainly during the early months of the year. Cod nets which are used in the first four months of the year are not adapted for the capture of flatfish, although, as is shown from the return of marked specimens, a few plaice may be caught each season by this method of fishing. Flounder net fishing which, until recently, was a small local fishery carried on in the Banff district for the capture of flatfish, has now been abandoned. Trawling within the Moray Firth is confined to non-British vessels which fish most intensively within the spawning areas during the spawning period. The method of fishing by Danish Seine Net is carried on most intensively by vessels based on the ports of Lossiemouth, Buckie and Aberdeen. The vessels fish on the same grounds as the trawlers and their greatest catches of plaice are obtained in the spawning period. Plaice caught beyond the three-mile limit in the Moray Firth by trawl and Danish Seine are almost all fish of good marketable size.

Cod.

A. Natural History.

Every year during the early months there is a concentration of mature spawning cod in the Firth. The large cod begin to arrive in the early weeks of January and thereafter the shoals increase in density during the spawning period from the end of January to the end of April and the spawning is at its height about the first week in March. The shoals disperse after spawning, most of the spent fish appearing to leave the precincts of the Firth. There are seasonal variations in the density and distribution of the shoals, but the main spawning areas lie within the Firth west of 2°50′ W. in the area fished by the cod nets. During the first year the cod seek the seaweed zone close inshore and during

the next two years they are found chiefly in the shallower coast zone, but as they grow older and larger they scatter, the larger immature cod not being found in any great numbers within the Firth.

B. Cod Fisheries.

The most important of the local cod fisheries is that carried on during the first four months of the year by cod nets. The catches consist almost exclusively of adult spawning fish.

The cod is the most important species in the great line catches. Both cod and codling are caught on the large hooks used but, as great lining within the Firth has been practically abandoned in recent years, the total weight of cod now caught in the area each year by this method of fishing is negligible.

The immature fish of the coastal zone are caught mainly by means of hand lines, the "ripper" being largely employed in this method of fishing. The fishing is carried on in close proximity to the coast, is local, and is comparatively unimportant with respect to the toll taken of the stock.

Few immature cod are caught by small lines, which are used mainly for the capture of haddock.

As in the case of the plaice, the period of most intensive fishing by non-British trawlers coincides with the spawning season. Large catches of mature cod are obtained on the grounds where the shoals concentrate.

Danish seine net fishing is carried on with greatest intensity during the early months of the year when the plaice species is the main objective and the plaice seine, which is not well adapted for the capture of cod, is chiefly used. The Danish seine net has not been in operation in the Moray Firth for a sufficiently long period to permit of any opinion being formed as to whether it is likely to become an important instrument for the capture of large spawning cod. During the period 1922—1925 (inclusive) steam Danish seine net vessels fishing from ports within the area landed 10,055 cwts. of cod and codling and of this total quantity 7,864 cwts. or 78.2 per cent. was captured in the first four months of the year.

Haddock.

A. Natural History.

The haddock is the most important species for the local fisheries and it is found generally distributed throughout the area. At the spawning period from February to the end of April mature haddock move offshore and, although spawning occurs in the Moray Firth area — except in the coastal waters of less than 20 fathoms —, the amount of spawning is negligible compared with that outside the Firth. There is considerable variation in the number of survivals and in the degree of dispersal of the broods of each year. The young haddock takes to a bottom

habitat about the month of August in the deeper waters, and it is only in certain years favourable for the production and dispersal of the brood that these young forms spread into the shallower waters of the Moray Firth. With increasing size and age, however, the young haddock gradually spread from the outer and deeper waters over the whole Firth with the exception of the shallow coastal zone of less than ten fathoms. They remain to feed and grow until they attain maturity, only making minor excursions between the shallower and deeper waters. They are a comparatively stationary stock. The fastest growers may become mature when two years old but practically all have reached maturity at three years. After spawning there is a return migration of the adult forms becoming marked about the month of August and culminating about the month of January. During this feeding migration into the Moray Firth in the summer and autumn months the oldest and largest forms appear to make the longest excursions. The stock of haddock in the Moray Firth is therefore a variable one consisting of the stationary population of immature forms of less than three years old and of temporary adult residents arriving during the summer and autumn and returning to the deeper waters before the following spawning period.

B. Haddock Fisheries.

By far the most important local fishery is that carried on for haddock by means of small lines, which is prosecuted throughout the whole year from all parts of the coast, reaching its greatest intensity during the period September to March. As a rule the small lines do not capture the haddock until they are $1^1/_2$ years old (20 cm.) but thereafter they are captured in increasing numbers.

Hand lines, which are employed mainly for the capture of cod in the near neighbourhood of the coast, take only a comparatively small number of haddock.

As haddocks are found distributed through the whole of the Firth outside the three-mile limit, they form an appreciable proportion of the catch of almost every trawl haul. The size at which a haddock may be caught by trawl depends on the size of the cod-end meshes used. These are such, however, that the haddock may be caught at the small size of 18 cms. The operations of the trawl therefore destroy a large proportion of the stationary population of the Firth between the sizes of 18 and 25 cms.

The seine net acts similarly to the trawl but under present conditions is much less destructive of the smaller sizes.

SECTION IV.

Conflicts between Trawling and Local Methods of Fishing.

Apart from the general complaints of line fishermen, such as complaints as to the destruction of spawn, spawning beds and fishing grounds, the breaking up

of shoals, the destruction of immature fish, overfishing and depletion of the inshore grounds, the visits of non-British trawlers to the Moray Firth have given rise to specific complaints in respect of the damage to fishing gear. Complaints in respect of damage to lines, though occasionally made, have not been numerous but much damage to the anchored cod-nets is reported and it is clear that the fishermen who use this type of gear have suffered considerable loss. The most serious damage occurred in the year 1921 when the reported losses amounted to over £3,000. The possibility of a recrudescence of the damage on an enhanced scale is always present and the fishermen state that the expense of new gear and apprehensions of further losses are serious obstacles to the normal development of the cod-net fishing.

Collisions between seine net vessels and cod net gear are of very infrequent occurrence although the seine net vessels work on the same grounds. The seine net vessels operate only in daylight and are generally familiar with the dispositions of the cod-nets and can therefore easily take measures to avoid them.

SECTION V.

The Effect of Fishing upon the Stock of the Principal Fish.

(1) **The Plaice.** As has been pointed out in Section III, small lines and codnets take very few plaice and may safely be disregarded from the point of view of their influence upon the stock. The effects of trawling and Danish seining are, however, important and must be carefully considered. The evidence is quite definite that the most intensive fishing by trawls and Danish seines takes place in the months January to April on the chief spawning grounds, which lie mainly to the west of 2°50′ W., and affects principally large and spawning plaice. Outside the spawning time plaice are more generally distributed but show the usual tendency to diminution in numbers and to increase in average size with increasing depths. The undersized plaice, under about 26 cm., are largely concentrated in certain shallow areas within the coastal zone and are therefore not fished to any appreciable extent. The use of both trawl and Danish seine is prohibited inside the exclusive fishery limits of the Moray Firth. The plaice reaches maturity at a relatively large size. In the Firth the mean size of the male plaice at first maturity is not less than 33 cm., while that for the female is not less than 35 cm.

It is clear[1] that the Moray Firth spawning area is the most important of all for the plaice of the East Coast of Scotland. Many of the fry remain inside the limits of the Firth, others are distributed by the currents, at least in certain years, to the areas to the southward. The Scottish stock is more or less self-con-

[1] A. Bowman: The Distribution of Plaice Eggs in the Northern North Sea. II. Fisheries, Scotland, Scientific Investigations 1921, No. 1 (1921).

tained and the Moray Firth area as the principal spawning area is of great importance for the recruitment of the stock. Although this stock is already protected by the fact that the small fish within the Firth are largely immune from capture, the evidence available suggests that the stock is depreciating in size and value. For the years 1905—1912 it has been shown[1] that the average catch per voyage of large plaice fell steadily throughout the period on the East Coast grounds. This is also borne out for the years 1901—1910 by Fulton[2] who writes: "The statistics above discussed show that the plaice as a species has diminished in abundance, or at all events in weight landed per unit of fishing, during the ten years over which the statistics extend, and this conclusion is in agreement with the opinions so often and strongly expressed by the practical men".

This decline was arrested by the protection afforded by the war and turned into an increase, which was very striking in medium plaice in 1919 and in large plaice in 1920 and 1921[3]. The figures for subsequent years have not yet been fully analysed but it is known that they show a progressive decline in the abundance of large and medium plaice from the high figures characteristic of the years immediately after the war.

It would appear, therefore, having regard particularly to the pre-war evidence of decline, that in order to maintain the Scottish stock of plaice some measure of protection for the spawning fish in the Moray Firth is desirable in addition to that naturally afforded by the concentration of the small fish inside the territorial limits of the Firth. Such a measure cannot be regarded as of general application and can be defended only in such cases as the present when the stock is limited in extent and circumscribed in distribution. As to the economic side, it might be urged that, as the stock is relatively a small one, it is unnecessary to take any special measures to conserve it. The landings of plaice on the East Coast of Scotland during 1925 amounted to 48,251 cwts., valued at £136,053. Against this point of view the argument may be advanced that the plaice fishing on the East Coast of Scotland is of great importance to the local fishermen on account of the great demand for the fish and the relatively high prices obtained. While the average value of the haddock landed on the East Coast of Scotland in 1925 was 19/1d. per cwt., that for plaice was £2:16:5d. per cwt.

The experiment of protecting the main spawning ground for this local stock would be of great general and scientific interest. We are of opinion that effective

[1] D'Arcy W. Thompson: Aberdeen Fishery Statistics. Fisheries, Scotland, Scientific Investigations 1913, No. 1 (1914), p. 8.

[2] T. Wemyss Fulton: On the Distribution and Seasonal Abundance of Flatfishes (Pleuronectidae) in the North Sea .... 1901—1910. Fifth Report (Northern Area) on Fishery and Hydrographical Investigations. Cd. 6950, 1913, p. 93.

[3] D'Arcy W. Thompson: Aberdeen Fishery Statistics 1917—21. Fisheries, Scotland, Scientific Investigations 1923, No. 1 (1923), p. 26.

protection could be given to the main group of spawners by the measures suggested in the concluding Section of this Report and that the effects of the protection could be gauged by scientific investigations continued over a sufficient period of years.

With regard to the capture of spawning plaice it is clear that trawlers and Danish seiners stand more or less on an equal footing, and that measures which excluded only the one method or the other from the spawning areas would be in large part ineffective, and would render the experiment inconclusive.

(2) **The Cod.** The evidence collated in Section III of this Report shows that the captures of codling by hand lines and small lines are not excessive and cannot be said to affect the stock prejudicially. The main fishing within the Firth is that carried out within the period January to April for spawning cod with trawls, cod-nets, and at present to a lesser extent with the Danish seine. These methods of fishing are concentrated in certain areas which lie almost entirely to the west of 2°50′ W. and undoubtedly take a considerable toll of this spawning stock. It must, however, be borne in mind that the quantities taken are relatively small compared with the landings in these months of mature cod from the other and more important spawning areas in the North Sea, e. g. from the Flamborough Off Ground, the Fisher Bank and others. The spring fishing for large cod is everywhere in the North Sea a fishing connected with the spawning concentrations[1] and the Moray Firth fishing is not unique in this respect. There is therefore no *prima facie* case on scientific grounds for singling out the Moray Firth stock of cod for special protection. Only if it were shown that this stock is a local one, that the same stock of fish returns year after year to the spawning grounds, and that they are the source of the local supply of small cod — only if this were established would there be a case for direct protection of the spawners in the Firth. Future investigations planned with a view to discovering by means of marking experiments and age-determination whether the Moray Firth cod are a self-contained stock or not may yield information on this point.

(3) **The Haddock.** While the haddock is the main objective of the small liners, it appears that the quantities taken (approximately 70,000 cwts. in 1925 from the Moray Firth) are not large and that few are taken of a smaller size than 20 cm. Haddock may be captured in considerable quantity by trawlers and Danish seiners, and there is no doubt that with intensive operations a great destruction of small unmarketable fish may take place. The trawl takes them from about 18 cm. upwards and most of those under 25 cm. are unmarketable, being almost entirely fish of the I- and II-year groups which are stationary in the Firth. The Danish seine (haddock seine) under the present conditions of mesh is less destructive to

[1] See Michael Graham and Collaborators: The Annual Cycle in the Life of the Mature Cod in the North Sea. Ministry of Agriculture and Fisheries. Fishery Investigations, Series II, Vol. VI, No. 6, 1923, Section 4.

the undersized fish than the trawl (see Paper No. 11, page 226), but the size taken in either case would appear to be a function of the size of cod-end mesh employed.

This destruction of small fish is undoubtedly wasteful and uneconomic, but it must be pointed out that the quantities destroyed in the Moray Firth are small in comparison with the great amount of destruction of small unmarketable haddock which is taking place in the North Sea as a whole. It is however important from the point of view of the local fishermen, inasmuch as it wastefully affects a stationary population of young fish which provides a good part of the livelihood of small liners and other local fishermen, many of whom cannot fish outside the Firth.

It should be added that the Firth is an unimportant spawning ground for haddock in comparison with the great spawning grounds outside.

SECTION VI.

The Effects of the Existing Closure.

To the question what effect the prohibition of trawling in the Moray Firth has had upon the total stock of fish in the North Sea it is impossible to give a definite answer. Reference has been made above in Section II to the activities of non-British trawlers and it was there shown that they fish principally in the early months of the year for mature cod and plaice. It is however impossible to estimate what would have been the effect had these trawlers been kept out. The prohibition not being of general application could not be expected to yield conclusive results.

As to its influence upon the well-being of the local fishermen it is impossible to make any definite statement, for the two reasons that the closure has been so incomplete and that the whole economic conditions have been transformed by the advent of the steam and large motor drifter and the introduction of the cod-net and the Danish seine net. It may be presumed that the exclusion of British trawlers has benefited the local fisheries by removing competition, but it is impossible to estimate this effect accurately.

SECTION VII.

Possible Modifications of Present Regulations.

It is shown in the preceding Section II that a considerable amount of trawling by non-British vessels has taken place within the Firth. The present prohibition of fishing limited in practice to British trawlers affords no effective protection and such protection can be obtained only by International agreement.

The question therefore arises whether such an agreement for the purpose of excluding trawlers belonging to all nationalities would be justifiable from a general as well as from a local point of view.

In our opinion the extensive experience gained through scientific investigations continued over a long series of years, as well as through the collection of accurate statistics and detailed information regarding the industry itself, is now sufficient to form a reliable basis for consideration of the question afresh. Referring to the appended review of the material at hand and to the preceding summary of what we consider the most important features of the fisheries, we suggest the following conclusions:—

A. The question may be considered from a scientific or more especially from a biological point of view.

Biologically, the strongest argument for the prohibition of trawling and similar methods of fishing arises from the consideration of the protection of the stock of plaice. The scientific investigations have, we think, satisfactorily demonstrated that the Moray Firth is the most important spawning area for plaice in the North Western part of the North Sea. The small immature plaice on the Scottish coast are found mainly within the territorial limits. Within these limits trawling by all vessels is prohibited but Danish seine net fishing by small vessels is permitted in certain areas south of Rattray Head. Within the Moray Firth area trawling by British vessels is prohibited and Danish seine net fishing is also prohibited within the territorial limits of the Moray Firth. It is very desirable in the interest of the stock of plaice that this latter prohibition should be maintained.

There is evidence that in spite of the restrictions on the fishing of the immature plaice the small and self-contained stock of plaice in the Scottish waters is depreciating in size and value. Although this stock is much smaller than the stock in the Southern North Sea, we consider that in the special circumstances an efficient protection of the spawning shoals of plaice within the Moray Firth would be an important measure which would benefit the plaice fisheries of the East Coast of Scotland. It may therefore be recommended as an subject for international agreement.

Besides the prospective beneficial effect on the North Western North Sea fisheries, the measure suggested would form an excellent basis for continued investigations for the purpose of determining the effect of protecting the main spawning part of a small and practically self-contained stock.

We are unable to decide whether a similar argument may be advanced in the case of the shoals of cod spawning within the area. The scientific material at hand does not in our opinion give conclusive evidence as to the question whether there is a special stock of cod spawning in the Firth or whether the spawning shoals form a part of the larger stock of the North Sea in the sense that the same individuals may in some years spawn within the Firth and in other years outside. The solution of this question is in our opinion of great general interest, and investigations planned for the purpose (marking experiments, regular annual analysis of

the composition of the stock with regard to year classes) are strongly recommended with a view to clearing up this point.

The extensive studies of the population of haddock within the North Sea have definitely revealed the fact that the main spawning areas of this species are outside the Moray Firth and that the main bulk of the young haddocks occurring within the Firth are immigrants from outside. It follows from this fact that the problem of protecting the stock of haddock in the Moray Firth is part of a problem common to the whole of the North Sea. Intensive work paving the way for future proposals in this direction is at present being undertaken in several countries. We take this opportunity to emphasise and support the recommendation made by the Scottish Departmental Committee on Trawling and Policing of the Scottish Sea Fisheries, who wrote as follows:— "All sections of the industry who appeared before us were agreed as to the need and desirability of remedial measures, and we recommend that the matter should be examined afresh by the Fishery Departments and by the International Council for the Exploration of the Sea. It would be very much in the interests of the fisheries if, in addition to size-limits for fish landed or sold, it were possible by international agreement to secure the general adoption of a larger size of mesh effectively operating in the nets used, and thereby to reduce the chances of capture of the smaller fish"[1].

It is, however, quite obvious that such investigations are still in the experimental stage and will take some years, and that the special conditions of the Moray Firth must be carefully considered irrespective of future possibilities. It should however be strongly emphasised that from a scientific point of view general measures for the protection of undersized haddock in the North Sea as a whole would have a most beneficial effect not only generally but also for the stock in the Moray Firth. It may safely be argued that such general protection would in the long run be the most effective way of conserving the young stationary stock and of augmenting the adult stock in the Moray Firth.

From the local point of view, however, we desire to draw attention to the important fact, explained in preceding Sections, that the stock of haddock at any time present in the Moray Firth is to be considered in part as a stationary one, in so far as it is composed of the young individuals which come in in the first years of their life and stay in the Firth for a year or two before they begin to migrate outside. The local fishing in the Firth is to a considerable degree dependent on this temporarily stationary young stock, which can support only a limited intensity of fishing. Older fish, however, visit the Firth as temporary immigrants and form part of the catch of the local fishery.

B. Suggestions of practical measures in the interest and for the protection of fisheries can obviously not be based on general biological considerations only.

[1] Report:— Trawling and Policing of Scottish Sea Fisheries. Edinburgh 1924, p. 58.

Having the object of benefiting human activities they must also take into consideration the special methods and conditions which characterise these activities.

We have more especially in mind the technically unavoidable conflicts between different kinds of gear fishing on the same ground and, further, the competition which may arise from the fact that the stock of fish in a given area may be quite insufficient for an unlimited application of gear of all descriptions in the area.

Conflicts between gear of different kinds are especially important within the Firth in the case of the contemporaneous use of cod-nets and trawls. The complaints of cod-nets (single nets or even the whole fleet) being carried away by trawlers are numerous. The danger of such collisions is increased by the fact that the cod-net fishing takes place during the night, that the fishermen have to leave the nets unattended, and that it is impossible to make satisfactory arrangements for lighting the buoys during the night. These nets are so concentrated on the ground that the distance between them may on occasions be less than a quarter of a mile. The regulations contained in the North Sea Convention, Article 15, do not meet the case. The very possibility of trawlers fishing on the cod-net grounds makes the cod-net fishing so difficult and risky that the question arises of reserving these grounds for the one or the other method during that part of the year when cod fishing takes place in the Firth.

The competition for the stock of fish is especially serious in the case of the haddock fishing. Different kinds of gear — small lines, haddock-seine, and trawls — are competing for the catch of the stock of haddock in the Firth and it seems more than doubtful whether this stock would be able to support an unlimited increase in trawling or seining besides the fishing now going on in the Firth. It may therefore be feared that the effect of opening the Firth to all trawlers would be to prejudice the activities of the local fishermen. In view of the fact that trawling in its present form is considered a very wasteful method of fishing, the question arises of the desirability of giving preference to the local fishing.

C. Having considered the various arguments for and against the exclusion of trawlers from the whole or part of the Moray Firth, it is necessary to consider what practical measure or measures would be needed to achieve the ends advocated.

For the adequate protection of the ripe plaice the obvious plan would be to prohibit all important plaice fisheries in the spawning area during the concentration period. The catch of plaice in this area is practically confined to two kinds of gear, the trawl and the Danish plaice seine. As a logical consequence of this, the measure of forbidding both these types of gear in the area and within the period indicated suggests itself, and we are of opinion that such a measure in the long run would be the best for the general interest of the plaice fisheries in the North-western North Sea.

The exclusion of trawlers from the main spawning areas during the segregation period of the plaice would not only protect the spawning plaice but also meet the demands for protection of the cod-net fishermen since the fishing with cod-nets coincides approximately in area and time with the fishery for mature and spawning plaice.

The problem of giving protection to the haddock fisheries within the Moray Firth is in many ways different from the problem we have discussed above. We see no valid argument from a purely scientific point of view, that is to say, from the point of view of protecting the stock of haddock of the North Sea, for any measure excluding trawlers from the haddock grounds. It seems to us obvious that any proposal of this kind must openly admit that its real purpose is to protect the fishermen of the Moray Firth. It is true that trawling is a more destructive method of fishing than the local haddock fisheries in the Firth, but such a destruction, however great it may be from the local point of view, is small in comparison with the great destruction by trawlers taking place outside.

The question of giving protection to the local haddock fisheries in the Moray Firth for the benefit of the local fishermen must be regarded as outside the scope of any committee appointed by the International Council and is a matter for discussion between the Governments concerned.

To sum up — we make a definite suggestion for the experimental closure of some part of the Moray Firth, with a view to protection of the spawning plaice. This proposal would entail the exclusion of trawlers and seiners from part of the Firth during part of the year. The area and period of closure will have to be further considered and defined in the light of the many practical and administrative considerations involved. We further recognise that there are social and practical considerations affecting the well-being of the local fishermen which cannot be dealt with by this Committee because of its purely scientific character. In all these circumstances we recommend that the International Council, if it accepts this Report, should refer it to the Governments concerned who alone are in a position to decide what action can be taken.

If the Governments concerned decide to give effect to the above proposal for closure, we suggest that an adequate scheme of investigations, both biological and statistical, should be drawn up under the auspices of the International Council with a view to ascertaining the effect of the measures adopted on the particular stock of plaice concerned.

Johan Hjort. Johs. Schmidt. E. Ehrenbaum. G. Gilson.
L. Verbrugghe. J. J. Tesch. E. S. Russell. Alexander Bowman.

H. J. Crowe,
Secretary to the Committee.

Ostend, 5 April 1927.

Report of Moray Firth Committee of the International Council for the Exploration of the Sea.

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Paper No. 1.

The Closure of the Moray Firth to Trawling.

A Historical Account of the Problem with a General Survey of the Fisheries of the Firth

by

H. J. Crowe.

I.

Genesis of Problem.

Introduction.

The Moray Firth is a bay on the North East of Scotland which is regarded as lying within an imaginary straight line drawn from Duncansby Head in Caithness to Rattray Head in Aberdeenshire. The length of this line is approximately 73 geographical miles and the area of water enclosed is about 2,020 geographical square miles of which about 1,517 square miles lie outside the three-mile limit. The Firth (see Chart, page 19) is divided for purposes of fishery administration into seven districts, viz., Fraserburgh, Banff, Buckie, Findhorn, Cromarty, Helmsdale and Wick (with Lybster). Lybster was formerly a separate district but is now merged in the Wick district which extends along the North Coast of Scotland as far as Cape Wrath.

From early times the Firth has been a valuable and important fishing area and has been the main source of livelihood for the population of some 70 villages and towns along its shores. It is recorded that in 1707, the year of the Union of the English and Scottish Parliaments, the herring fishing fleet of the Moray Firth consisted of from 500 to 700 boats each manned by 6 or 7 men. Since that time the industry in the Firth has undergone many fluctuations but it has always remained of value and during the latter part of the period it has attained a position of great importance. The annexed statement, (Statement No. 1, pages 20—21) shows the position as regards the fisheries within the various administrative districts of the Firth n 1925.

It will be seen that the fishing vessels belonging to Moray Firth ports in 1925 numbered 1,828 and that the number of resident fishermen was 8,672, which

is nearly one-third of the total number of fishermen in Scotland. As explained later, the Moray Firth fishermen pursue the herring fishings extensively in waters outside the Firth, and they were credited in 1926 with landings of herrings amounting to 2,610,066 cwt. and valued at £1,269,011 (that is about one-third of the total landings of herrings in the whole of Great Britain and Ireland) in addition to landings of white fish exceeding 160,000 cwt. in quantity and £200,000 in value. The herrings caught form the basis of a valuable and important curing industry. The cured herrings, which constitute a cheap and nutritious article of diet, are mainly exported for consumption in Germany, Poland, Russia, and other North-European countries, so that in this way the activities of the Moray Firth fishermen are related to the well-being of large European populations.

Various circumstances have favoured the rise of this important and distinctive aggregation of fishing communities in the Moray Firth. The coastal population have been endowed in a large measure with the qualities of vigour, enterprise, and thrift requisite for the active pursuit of sea fishing as a regular calling and they have been assisted in the prosecution and development of the industry by the fact that the Firth by reason of its configuration affords at nearly all seasons of the year sheltered areas in which fishing from small boats can be carried on safely and with a minimum of interruption. In earlier years, when only small open rowing and sailing boats were available, the range of the fishermen was necessarily restricted and the home waters were of relatively greater importance for actual fishing operations than they are at present.

The vital interest of the local population in the fishings of the Firth has been vigorously asserted in the past. It was reported by Commissioners in 1631 in connection with the proposed establishment of a Society for the development of the British fisheries that no Englishman, nor other foreigner, had ever been allowed to fish within 14 miles beyond a straight line drawn from Buchan Ness to Duncansby Head; and efforts were made to exempt the Firth from the operations of the Society and to reserve it for the use of the local fishermen.

Development of Trawling. This traditional attitude towards any encroachment by stranger fishermen in the Firth was quickened into activity by the enormous expansion of trawling, brought about by improved means of communication, the opening of new markets, the increased use of ice, the introduction of steam trawlers, the use of the otter trawl, and other factors, which commenced about the middle of last century and is the most outstanding feature of recent happenings in the fishing world. The facts relating to this movement are too well known to need narration here; it is sufficient for the present purpose to state that trawling spread into Scottish waters and developed at Scottish ports — trawl caught fish was first landed at Aberdeen, now the third trawling port in Great Britain, in the year 1874 — and to refer to the great administrative and scientific problem created by the conduct of intensive trawling on the great scale attained,

viz., the problem of over-fishing and impoverishment of fishing grounds. It is not too much to say that this problem has become the overshadowing question for fishery scientists and administrators and in one form or another has been the main preoccupation of the International Council for the Exploration of the Sea since the formation of the Council in 1902.

Restrictions on Trawling. On the administrative side in Great Britain, and particularly in Scotland, the problem speedily became acute owing to the effect of trawling on the position of the inshore fishermen, whose livelihood was menaced not only by the severe competition of the large quantities of fish landed by the trawlers but by the heavy toll taken by the trawlers of the fish on the fishing grounds, including often areas frequented by the line fishermen themselves. Measures for the protection of the inshore fishermen soon became necessary, and following a Report by a Royal Commission in 1885 the Fishery Board for Scotland, who are the administrative body charged with the supervision of the Scottish Sea Fisheries, were empowered by the British Parliament by the Sea Fisheries (Scotland) Amendment Act, 1885, to make Byelaws restricting or prohibiting within the British exclusive fishery limits in any part of the sea adjoining Scotland any method of fishing which they were satisfied was injurious to any other method of sea fishing or where it appeared to the Board desirable to make experiments or observations with the view of ascertaining whether any particular mode of fishing was injurious or for the purpose of fish culture or experiments in fish culture.

By virtue of these powers the Fishery Board for Scotland, for the purposes of experiment as to the effects of trawling, proceeded to close to beam trawling certain areas off the East Coast of Scotland, including in 1887 the territorial waters in the Moray Firth from Kinnaird Head westward along the south coast and along the north coast as far north as the Ord of Caithness.

In 1889 as a result of investigations carried out the Board expressed the view that beam trawling was injurious to the sea fishings. In the same year, by the Herring Fishery (Scotland) Act, 1889, beam or otter trawling was prohibited within three miles of low-water mark of any part of the coast of Scotland and in certain bays including the Firth of Clyde, and in addition the Fishery Board were empowered to close to trawling the whole or any part of the Moray Firth.

In the following year a Byelaw was passed prohibiting trawling in the inner portion of the Moray Firth inside a line drawn from the Ord of Caithness to Craighead, Buckie, comprising an area outside the three-mile limit of about 333 geographical square miles; and in 1892, following a Petition presented on behalf of 7,294 fishermen, the prohibition was extended to the whole of the Firth, the Byelaw to that effect being confirmed by the Secretary for Scotland on the 22nd of November 1892. The Byelaw was amended in a technical detail by a further Byelaw which was confirmed on the 6th of August 1896.

It is to be noted that the object of the Byelaws and the Act which authorised

them was not to claim exclusive fishing rights in the Moray Firth but merely to make regulations as to certain modes of fishing in the Firth by whomsoever practised, whether British or non-British subjects. Fishing of any kind by non-British vessels in British exclusive fishery limits was prohibited by an Act passed in 1883 to give effect to the North Sea Convention of 1882.

Incursion of Non-British Trawlers. The closure of the extra-territorial waters of the Firth to trawling by British vessels has been maintained, but it could not be made effective against non-British trawlers, which from 1895 onwards have frequented the Firth in considerable numbers. Certain vessels owned in England but registered at Scandinavian ports took the opportunity for a time to trawl in the Firth under cover of a foreign flag; and altogether so many trawlers were engaged, particularly in the years just preceding the War of 1914—1918, that the Firth may be said to have been practically open to trawling.

British fishery cruisers systematically employed in patrolling the Firth have since 1899 kept records of the non-British trawlers observed working and a statement (Statement No. 2, page 22) is appended showing, under their various nationalities, the numbers of trawlers and the numbers of occasions on which they were observed working. During the War years 1915—1918 no non-British trawlers visited the Firth. Bowman in Paper No. 10 has made a detailed examination of the records of the occurrences of the non-British trawlers with special reference to the loci and seasons of fishing. Since the War the numbers of non-British trawlers observed have been small, but the possibility of a resumption of the operations on a larger scale in future years must be kept in mind. The question of damage to anchored cod-nets caused by the operations of the trawlers since 1906, when the anchored cod-net fishing commenced in the Moray Firth, has been and still is an acute phase of the problem and is dealt with elsewhere in this paper (pages 15 and 16).

The landing at Scottish ports of catches taken by trawlers in the closed areas was prohibited by a clause of the Act of 1889 above referred to; and action under this clause was taken successfully against a German trawler in 1897. With a view to discouraging the visits of non-British trawlers to the Firth, the Trawling in Prohibited Areas Prevention Act, 1909, was passed prohibiting the landing at any British port of fish taken in the Firth and other areas in which trawling was prohibited.

Remit to International Council. The closure of the Moray Firth was investigated in 1923 by a Scottish Departmental Committee appointed to consider the general question of trawling in Scottish waters. The Committee recommended that energetic measures should be taken to secure the international recognition of the closure so that the existing anomaly whereby non-British trawlers are admitted to the Firth and British trawlers are excluded might be removed and that, subject also to international agreement, the Fishery Board for Scotland should

be empowered to prohibit equally with trawling in the extra-territorial waters of the Firth any other method of fishing which they might be satisfied was injurious to any kind of sea fishing within the area.

It is in accordance with these recommendations that the matter has been referred to the International Council for the Exploration of the Sea for consideration.

II.

Scientific Investigations carried out.

When the closure of the Firth was first applied, scientific investigations were instituted with the view of ascertaining the effect on the fisheries of the prohibition of trawling but the investigations were to a great extent vitiated by the incursion of non-British trawlers into the Firth. The difficulty experienced from this cause in conducting the investigations was considered by the International Conference held at Christiania in 1901 when the following Resolution was passed (Report of Conference, Resolution E, page 25):—

> "In distinct areas of the sea — as, for example, the Moray Firth — in which any Government has undertaken experiments in the interest of the fisheries and in which the success of the experiments is being hindered by the operations of trawlers, it is to be desired that measures be adopted for the removal of such hindrances."

Trawling experiments were carried out in the Firth from 1887 to 1904 as far as was possible with the means available. With the small research vessel, the "Garland", normally employed, the experiments could, however, be made only in favourable weather conditions generally in inshore waters, and regular and systematic operations throughout the Firth were not possible. Records of Observations made on the "Garland" and on certain commercial trawlers which were occasionally employed are given in detail in Part III of the Annual Reports of the Fishery Board for Scotland for the period.

In 1902 Scotland assumed responsibility for a large share of the international programme of researches, and although in 1904 a larger research vessel, the "Goldseeker", became available, she was fully occupied in connection with the international researches, and investigations in the Moray Firth could be carried out only intermittently and as part of the larger international scheme. Although the main object of the scientific investigations in the Firth has not been achieved, much valuable information has been gained regarding the physical, hydrographical and biological conditions in the Firth. The undermentioned scientific publications issued since that year either relate to investigations carried out in the Moray Firth area or have a bearing on the Moray Firth problem:—

a) Observations on the Plaice from the "Goldseeker" Experiments and from Statistics of the Aberdeen Market.
By Professor D'Arcy W. Thompson.
North Sea Investigations, Fifth Report, 1908—1911.

b) Report on the Distribution and Seasonal Abundance of Flatfishes (Pleuronectidae) in the North Sea and the Fluctuations in their abundance during the years 1901—1910.
By Dr. T. W. Fulton.
North Sea Investigations, Fifth Report, 1908—1911.

c) Report on Marking of Plaice and other Fish by the s.s. "Goldseeker" in the years 1904—1909.
By Dr. Fulton.
North Sea Investigations, Fifth Report, 1908—1911.

d) Report on Marking of Plaice and other fish by the s.s. "Goldseeker" in the years 1910—1913.
By Dr. Fulton.
Fishery Board for Scotland, Scientific Investigations, 1919, No. 1.

e) Second Report on the Distribution of the Cod and other Round Fishes.
By Professor D'Arcy W. Thompson.
(Rapports et Procès-Verbaux, International Council, Vol. XIII, C. 2).

f) Aberdeen Trawling Statistics.
By Professor D'Arcy W. Thompson. (Various dates.)
North Sea Investigations (Scotland), First Report, 1902—1903.
— — — (Northern Area), Third Report, 1904—1907.
— — — (Northern Area), Fifth Report, 1908—1911.
Fishery Board for Scotland, Scientific Investigations. 1913, No. I.
— — - — — — 1914, No. III.
— — - — — — 1917, No. I.
— — - — — — 1923, No. I.

g) Distribution of Plaice Eggs in the Northern North Sea.
By A. Bowman.
1) Fishery Board for Scotland, Scientific Investigations, 1914, No. II.
2) — — - — — — 1921, No. I.

h) Haddock Biology II. Frequency and Distribution of the Age Classes in 1923.
By Harold Thompson.
Fishery Board for Scotland, Scientific Investigations, 1924, No. I.

Investigations in the Moray Firth have been continued and are still being carried on as opportunity offers.

Statistics. Special statistics of the line fishings of the Moray Firth Districts Banff to Wick were kept from 1894 to 1916 and in these statistics from 1904 the catches of the different methods of line fishing, namely with small, hand and great lines, were distinguished. The statistics from 1904 are summarised and analysed by Bowman in Paper No. 7. Efforts have been made from time to time to obtain statistics of the catches of non-British trawlers in the Firth but only scanty and incomplete particulars are available.

III.

Progress of the Fishing Industry in the Moray Firth since 1892.

A review of the progress of the fisheries of the Moray Firth since 1892 — the date of the prohibition of trawling throughout the Firth — reveals a number of important changes in the distribution of the fishing population, the composition of the fishing fleet and the methods of fishing employed.

A statement is annexed (Statement No. 3, page 23) showing for the various districts of the Firth the numbers of resident fishermen and boys for the years 1892 to 1925. It will be seen from this statement that the total numbers of fishermen throughout the whole Firth, though fluctuating, have been fairly well maintained. The average total for the period, excluding the War years, is 9,282. In the north shore districts, however, there has been a consistent and pronounced decline, amounting in the case of Wick and Lybster to nearly 67 per cent. The town of Wick remains a very important centre for the landing and curing of herrings, the amount landed during 1925 being 484,900 cwt. valued at £275,993, but for various reasons it has not developed a local fleet at all commensurate with its importance as a herring fishing centre and its trade depends very largely on landings by stranger vessels.

It will be seen from the Statement No. 1 on pages 20—21 that the local fishing activity is centred mainly on the south shore of the Firth. Of 8,672 resident fishermen with 1,828 fishing vessels of a total tonnage of 31,625 tons, 7,441 fishermen with 1,434 vessels of a total tonnage of 28,764 tons belonged in 1925 to the four districts on the south shore and only 1,231 fishermen (including 88 part-time fishermen) with 394 vessels of a total tonnage of 2,861 tons lived on the north shore. The great majority of the larger vessels belong to south coast ports; only 22 steamers are included in the north shore fleet, which has an average tonnage of 7 tons as against an average for the south shore fleet of 20 tons. Apart from the herring fishings the fishermen of the north coast of the Firth engage chiefly in small and hand line fishing and have not adopted other methods of fishing to the same extent as the fishermen of the south shore. The process of decline of line fishing communities is in evidence on other similar stretches of coast in Scotland and is attributable to various causes such as the use of larger vessels involving concentration in larger ports, difficulty of access to markets, severe competition with other sources of supply, the attractions of town life for the younger generation, and the practical difficulties attending the pursuit of line fishing itself.

In certain localities the fishermen have turned largely to other methods of fishing and have succeeded in maintaining their numbers. In the south shore districts of the Moray Firth, where the great herring fishing fleet has been mainly developed and where new methods such as cod-net fishing and seine net fishing

have been extensively adopted, the numbers of resident fishermen have increased to an extent which has more than compensated in most years for the reduction in the numbers on the north coast. There has, however, been a marked falling-off in the numbers on the south shore since the War. Buckie, which possesses the largest drifter fleet of any port in Great Britain, shows a decline of over 800 men since 1920; and considerable reductions have taken place since that year in all the other districts. This post-war falling-off is mainly attributable to the depressed condition of the herring fishing industry resulting from the dislocation of the European markets for cured herrings.

The Fishing Fleet.

The changes in the composition of the fishing fleet of the Moray Firth since 1892 are indicated in the attached statements (Statements No. 4—11, pages 24—31) showing for each year up to and including 1925 the numbers of steam, motor and sail vessels of different classes belonging to each district and to all the districts combined. The great feature of the period has been the adoption of artificial means of propulsion with a resultant reduction of the number of sailing vessels employed. In 1892 the total fleet of 3,339 vessels comprised 3,338 sailing ships and only 1 steamer. In 1909, when motor boats first came into use in the Firth, there were 2,136 sailing vessels, 406 steam and 22 motor vessels, making a total of 2,564 vessels. In 1925 the fleet consisted of 711 sailing vessels, 594 steamers and 523 motor vessels — a total of 1,828 vessels. The capital value of the total fleet of 3,339 vessels in 1892 was approximately £ 294,000; the fishing gear used in that year had an estimated value of £324,000.

In 1925 the capital value of the 1,828 vessels employed was approximately £1,100,000 and the value of the gear used was about £520,000.

The steamers, which are used mainly in the herring fishings, represent by far the most valuable part of the fleet, the 594 steam vessels employed in 1925 having an estimated value of over £900,000 with gear of the value of approximately £400,000. In 1914 the steam fishing fleet of the Firth attained a maximum number of 662 with an estimated value of £1,500,000 and gear valued at approximately £250,000.

The steam vessels, which are centred mainly at Buckie, Lossiemouth, Macduff and Fraserburgh, were nearly all built during the years 1900 to 1914. Since the War, owing to the general depression in the herring fishing industry, only about 60 new steam drifters have been added to the fleet. The steam drifters range in length from about 70 to 90 feet, in tonnage from about 30 to 50 tons, and carry crews of 8 or 9 men.

Motor vessels first came into use in the Firth in 1909, but the greater part of the motor fleet has been developed since 1914. The majority of the vessels are

now from 18 to 30 feet in length of keel; the vessels over 45 feet keel, which formerly were in the majority, have declined rapidly in numbers since 1919, many of them having been originally sailing boats which were equipped with motor engines and have now gone out of service.

In 1925 the motor boats in the Moray Firth had an estimated capital value of about £143,500, with gear valued at about £120,000. In that year 180 motor boats with a total tonnage of about 7,200 tons (average 40 tons) were engaged mainly in herring fishing, and 335 with a total tonnage of about 2,000 tons (average 6 tons) were engaged mainly in fishing for white fish.

The motor boats, which carry from 4 to 7 men, are employed in all the districts of the Firth but in greatest numbers on the south shore, principally Fraserburgh and Banff. Buckie, the chief centre of the steam vessels, possessed in 1925 only 54 motor boats.

The sailing fleet in 1925 consisted almost entirely of vessels under 18 feet and from 18 to 30 feet in length of keel. Only 13 sailing vessels of larger size were employed in the Firth. 259 vessels (of which all but 2 are under 18 feet in keel), constituting more than one-third of the total sailing fleet of the Firth, were centred at Fraserburgh; 237 belonged to the north coast (Cromarty, Helmsdale and Wick); 118 to Buckie; 89 to Banff; and only 8 to Findhorn. In 1925 the capital value of the sailing fleet was about £11,000 and the gear used was valued at about £14,000. White fishing is the principal occupation for the sailing vessel, but many of them are employed in the herring fishings, about 200 of them being so engaged in 1925. The sailing boats carry from two to five men.

Changes in Fisheries of the Firth since 1892.

As will be seen from the appended Statement No. 12, page 32, the principal species of food fishes caught in the Moray Firth in 1925 were haddock, cod and plaice, of which haddock and cod were much the most important. The Statement No. 13, page 33, shows the quantities of (1) Cod and (2) Haddocks and also the total quantities of (1) Round Fish and (2) Flat Fish landed in the Moray Firth districts from 1892 to 1925 inclusive.

Before 1906 the white fish in the Firth were, apart from the catches of non-British trawlers, practically all taken by line. In 1906 an important new method of capture was introduced, namely anchored nets for the capture of cod; and cod-net fishing has since been consistently and extensively followed in the Firth. The method is described in the succeeding Section of this paper and the statistics of the fishery are analysed by Bowman in Paper No. 8.

A further important innovation was the introduction of Danish seine net fishing in 1921. This method, which is used mainly for the capture of flat fish, is also described in Section IV of this paper (p. 16).

Statements are annexed (Statements No. 14—21, pages 34—37) showing the total quantities of cod, haddock, all round-fish and all flat-fish taken by lines, cod-nets and Danish seine net and landed in the districts of the Firth combined and in each of the districts during the years 1922 to 1925 inclusive. The statements do not include the fish taken by Danish seine net in the Firth and landed at Aberdeen, but allowing for such landings the line fishings remain by far the most important of the local fisheries of the Firth.

The fish caught by small and hand lines landed at Moray Firth ports during 1925 amounted to 110,356 cwt. of a value of £113,358, of which 68,669 cwt. valued at £77,094 consisted of haddocks. By far the greater portion of the catch can be ascribed to small lines. The great line catch in the Moray Firth during 1925 did not exceed 5,000 cwt.

As will be seen from Statement No. 13, page 33, the line fishings of the Firth have seriously diminished in importance since the early days of the closure of the Firth to trawling. In those days the herring fishings were much less extensive and persistently followed than they are at present, and the line fishings, as practically the only alternative method of fishing, received attention from a considerably larger body of men and for considerably longer periods of the year. The development of the herring fishings consequent on the introduction of the steam drifter led to a great diversion of man-power from the line fishings and has undoubtedly been the principal contributory cause of their decline. The line fishing ranks were further depleted by the introduction of cod-net fishing in 1906 and Danish seine net fishing in 1921. As stated elsewhere, the decline of line fishing is also attributable to other factors such as the lack of ready access to markets, severe competition with other sources of supply, the attractions of town life for the younger generations, and the practical difficulties attending the pursuit of line fishing itself, as, for example, the difficulty of securing bait and labour for the baiting and clearing of the lines. The lines were formerly baited and "redded" by the female members of the fishermen's families, but of late years women have in many districts shown a disinclination for laborious work of this kind. It is to be noted that in certain of the fishing villages of the Banff district where this difficulty has not developed to the same extent as elsewhere and where other favourable conditions obtain, the line fishermen enjoy a fair measure of prosperity. The operation of the general factors which have made for the decline of the line fishings is most noticeable on the north shore of the Firth where, as previously stated, the fishing population has shown a marked falling off. It is not clear how far the prevalence of trawling by non-British vessels in the Firth has contributed to the decline.

IV.

Present-Day Methods of Fishing in the Moray Firth.

The principal methods of fishing in the Moray Firth at the present time are:—

(1) Drift-Net fishing for Herrings;
(2) Trawling;
(3) Line Fishing;
(4) Cod-Net Fishing;
(5) Danish Seine Net Fishing.

(1) Herring Fishing.

The drift-net fishing for herrings is by far the most important occupation of the Moray Firth fishermen and is prosecuted by them in great numbers and with great vigour almost entirely in waters outside the Moray Firth. The great bulk of the important Scottish herring fishing is in the hands of the Moray Firth men. Within the Moray Firth itself, apart from a small winter fishery in the Inverness and Beauly Firths, fishing for herrings by means of drift nets is carried on only in the north-east and outer portions in the months of August and September as part of the great summer herring fishing. The closure of the Moray Firth to trawling may be said therefore to present no problem so far as the herring fishings themselves are directly concerned, although the fortunes of the herring fishings affect profoundly the economic position of the fishermen and the extent of their participation in the local fisheries.

The importance of the herring fishings to the Firth may be gauged from the extent of the local man-power which they absorb. Out of about 8,670 resident fishermen in the Firth, about 4,350, or more than half, engage in herring fishing alone without any subsidiary method of fishing, and for about a further 3,000 herring fishing is the main pursuit but is supplemented by other methods or combinations of methods of fishing, of which the principal are seine net fishing, small lining, cod net fishing, great lining (chiefly from Fraserburgh in waters outside the Moray Firth) and hand lining. The remainder (about 1,300) of the resident fishermen represent the line fishermen depending directly on the supply of fish within the Firth. These are mainly the older and less active men, together with boys from whom the herring fishing crews are to some extent recruited.

The main herring fishing for the Moray Firth fishermen is the Great Summer Herring Fishery from Lerwick, Stronsay, Wick, Fraserburgh, and Peterhead, lasting from June to September, in which 4,908 fishermen from the Firth were engaged in 1926. About 1,428 Moray Firth fishermen engaged in 1926 in other Scottish herring fishings, principally in the winter months off the North and West

Coasts, the total weight of herrings landed from Scottish waters during the year being 1,562,189 cwt. valued at £821,511. The herring fishing next in order of importance to the summer fishing for the Moray Firth men is the East Anglian fishing during October and November from Yarmouth and Lowestoft, in which 677 Moray Firth boats and 4,786 fishermen engaged in 1926 and landed 952,620 cwt. of herrings, valued at £384,510. Many Moray Firth crews also prosecute the herring fishings off Ireland and off the Isle of Man. In 1926 the total landings of herrings by Moray Firth crews at all places visited was 2,610,066 cwt. valued at £1,269,011.

The pursuit of these various fishings necessarily occupies the greater part of the year; some of the fishermen are absent from home for as long as nine months in the year; so that the time available for alternative local fisheries is much restricted and varies according to the success and prospects of the herring fishings.

The Moray Firth fishing fleet engaged mainly in herring fishing during 1925 consisted of 188 motor drifters of a total tonnage of 7,468 tons and 594 steam drifters of a total tonnage of 20,279 tons. About 200 sailing herring drifters also fished from Moray Firth ports. These vessels with gear, most of which are owned by the fishermen themselves on a share system, represent a total capital value of about £1,500,000.

The development of this great fleet, which is concentrated mainly on the south shore at Buckie, Lossiemouth and Fraserburgh, has already been described. The introduction of steam took place at a time of great prosperity for the fishermen, when capital was available for the development of the fleet. Since the War, owing to the dislocation of the European markets for cured herrings, the herring fishing industry has passed through a period of great depression and operations have not been conducted on so extensive a scale as in pre-war years. Expenses have in general been so heavy, especially during 1926, that the fishings have yielded very poor returns to the fishermen, many of whom are placed in a position of great financial difficulty.

Only about 60 new vessels have been added to the fleet since the War and, as many of the existing vessels have already seen long service, the question of replacement at greatly enhanced shipbuilding costs is likely to arise in the not distant future. It is impossible to forecast developments but unless events take a more favourable turn one eventuality may easily be that the fishermen will be thrown back to a greater extent on the local fishings of the Moray Firth. The possibility of an increase in the intensity with which these fishings are prosecuted cannot be overlooked.

(2) Trawling.

Trawling in the Moray Firth is restricted to non-British vessels which visit the Firth mainly in the early months of the year for spawning cod and plaice. Particulars of the numbers and nationalities of the trawlers observed working

in the Firth since 1898 are given in Statement No. 2 on page 22. Statistics of the catches of the trawlers are not available.

(3) Line Fishings.

The line fishings, which are of three kinds, viz., great line, hand line, and small line, are carried on in the Moray Firth at the present time as a whole-time occupation (apart from a small amount of crab and lobster fishing) by about 1,200 fishermen, distributed throughout the districts roughly as follows:— Fraserburgh 240, Banff 190, Buckie 90, Findhorn 210, Cromarty 190, Helmsdale 90, and Wick 190. In addition about 100 men, of whom about 50 belong to the Banff district, supplement the line fishings with seine and cod-net fishing. These 1,300 fishermen are composed for the most part of the older and less active men and of boys who do not go to the herring fishings. For the older men the line fishings constitute a suitable occupation while for many of the boys they supply a useful training preliminary to service on the herring drifters.

In addition to these men, for whom the line fishings are the main pursuit, the line fishings are carried on at intervals by fishermen who are engaged for the greater part of the year at the herring fishings, the time and energy devoted to the line fishings by these men depending on the prospects or success of their primary occupation or of other alternative fisheries. These herring-cum-line fishermen in the Firth number in all about 1,200, including about 230 fishermen at Fraserburgh whose work — with great lines — lies principally outside the Moray Firth. About 400 of the herring-cum-line fishermen belong to the Banff district, about 210 (in addition to the 230 great-line fishermen just mentioned) belong to Fraserburgh, about 140 to Helmsdale, 110 to Wick, 110 to Cromarty, 20 to Lossiemouth, and practically none to Buckie where the fishermen have adopted seine net fishing and cod-net fishing in preference to line fishings as auxiliary occupations.

The rise of motor boats has considerably increased the range and catching-power of the line fishermen. The development of the motor fleet in the several districts of the Moray Firth is indicated in the Statements No. 4—11 on page 24 et seq. For line fishings the smaller class of motor boat is generally used.

Small Lines. Of the three kinds of line fishing, the small line fishing is by far the most important in the Firth. It is centred mainly in the Banff district whence it is prosecuted by about 640 fishermen of whom about 400 are mainly herring fishermen. Findhorn, Helmsdale, Cromarty and Fraserburgh districts supply respectively about 240, 170, 150 and 100 whole and part-time small-line fishermen; in the remaining districts the amount of small-line fishing is relatively unimportant.

The fishing grounds frequented by small liners are scattered throughout the Firth. In most of the districts the fishing is in the main restricted to the neighbouring offshore grounds from 1 to 8 miles from the coast but in certain districts

the fishermen venture further afield, notably the Banff and Helmsdale men who visit Smith Bank, and the Fraserburgh men who work about 12 to 16 miles off in a north-west and northerly direction. The fishing is prosecuted more or less all the year round but there are seasons of greater and less intensity in certain districts, e.g. December to April for Fraserburgh and September to May for Banff, and September to December for Cromarty. Smith Bank is most frequented in the summer months.

The larger motor boats will carry as many as 9 lines which may each extend for as much as 1,250 yards. Mussels are the principal bait used and represent a considerable item of expense. The lines are shot mainly in daylight or just before dawn; the fishermen stay by them and haul them almost immediately after shooting. Consequently cases of damage by other fishing gear to the small lines, which may sometimes be used on hard ground unsuitable for trawling operations, seldom occur.

The haddock is the mainstay of the small-line fishing, representing approximately 70 per cent. of the catch as against a percentage of under 6 for plaice. The haddock fishing by small lines is of great relative importance to the line fishermen and, carried on as it is practically all the year round and in all parts of the Firth, it constitutes one of the main grounds for the interest of the local fishermen in the exclusion of trawlers from the Firth.

Hand Lines. Fishing by means of hand lines in the Moray Firth is now relatively unimportant.

The chief centres for hand line fishing are Fraserburgh and Wick where respectively about 300 and 200 men are engaged. The fishing is prosecuted all the year round largely in inshore waters. A hand line may be as much as 60 yards long. "Ripper" fishing is a form of hand line fishing practised mainly by old men in the Wick and Fraserburgh districts. It is most effective in the months of March, April and May; while June, July and August are the principal months for baited hand lines.

Great Lines. Great line fishing in the Moray Firth was formerly of considerable importance but has been on the decline since 1900 and is now practically extinct in most districts. At Fraserburgh about 230 fishermen use great lines but principally in waters outside the Moray Firth. About six small motor boats generally fish from Fraserburgh from March till July within the limits of the Firth, their summer operations having been extended of late years in consequence of the poor results of the herring fishings. From the Findhorn district about six motor boats work with great lines in the Firth from April to September for hake, cod, ling, halibut and skate. From Cromarty about eight boats work during the winter and spring months according to the success attendant on the small herring and sprat fishery in the Inverness and Cromarty Firths.

Practically no great line fishing is carried on from the Banff, Buckie, Helmsdale and Wick districts.

(4) Cod-Net Fishing.

Cod-net fishing was first practised in the Moray Firth in 1906, and has since become a regular feature of the year's routine, affording during an interval between the herring fishings an important source of income. In 1925 it employed from 500 to 600 fishermen of whom fully 75 per cent. belonged to Buckie, which has become the principal centre for the fishing, the remainder belonging to the Fraserburgh, Lossiemouth, Cromarty, Helmsdale and Wick districts.

The statistics of the fishery are detailed and analysed by Bowman in Paper No. 8, but it may be stated here that the fishing in the year 1910 produced a maximum yield of 69,135 cwt. valued at £24,771; in 1914 the total catch was 41,164 cwt. valued at £21,879, but since the War there has been a considerable falling off and in 1926 the catch was only 12,693 cwt. valued at £12,254.

The cod-net fishing is carried on during the early months of the year January to April and is at its height during February and March. It is prosecuted mainly by steam and motor drifters but sailing boats and the smaller classes of boats also participate to a certain extent. As many as 225 vessels have been engaged at a time. The principal fishing grounds lie to the west of a line joining Clythness on the north shore of the Firth and Covesea on the south shore. Operations are also conducted in an area in the centre of the Firth from 14 to 28 miles north from Buckie, and in certain small areas, mainly within the territorial limits, off the south shore

The nets used are of 18 ply yarn, 120 yards in length, and 7 yards in depth, with a 9 inch mesh. They are kept in an upright position by strong hollow glass balls, about one pound in weight and five inches in diameter, which are covered with rope network to prevent breakage and to enable ropes to be attached to them. The nets are weighted with small sandbags of about six pounds in weight and from 14 to 16 inches in length. The large sailing boats and steamers each carry from 25 to 50 nets, the number used by smaller vessels varying according to the size of the craft, some of the small yawls employing only six. When mounted, the net is contracted to about 70 yards in length and owing to its loose setting the fish usually become entangled in the folds of the net. The nets are sometimes set at a distance of a quarter of a mile apart.

The procedure generally adopted by the fishermen is to set and anchor their nets and then return to port. If the weather is suitable the fishermen again proceed to the fishing grounds on the following day, haul, clear and reset the nets and return to port with the catch; but in the event of bad weather some days may elapse before the nets can be examined.

Damage to Cod-Nets. The cod-net fishing grounds coincide to a great extent with the grounds most favoured during the months January to April by non-British trawlers who are attracted by the spawning plaice and cod. The two methods of fishing on the same ground and at the same time are incompatible

as there is necessarily a great concentration of the cod-nets, and damage by the trawlers if they enter and fish the area is practically unavoidable, particularly at night when the nets are not lighted. Numerous complaints of damage and loss of nets have been made to the Fishery Board for Scotland, the claims reported amounting in one season, namely 1921, to over £3,000. Fewer claims have been received in later years, but at a time when the cost of replacing gear is high any loss from such a cause is a severe handicap to the fishermen, and the damage sustained, together with the fear of further loss, is represented as a cause of the decline of the cod-net fishing in recent years. Even if the trawler doing the damage is identified, which is always a matter of great difficulty and is in fact seldom possible, the procedure necessary to be followed for pressing a claim against a foreign vessel inevitably involves expense, difficulty and delay. Every effort has been made by the Fishery Board for Scotland to prevent the occurrence of damage. In 1914 they drew up for the guidance of the local fishermen Regulations as to the Marking and Lighting of the Anchored Cod-Nets (see Statement No. 22, page 38), but these have no statutory force and the fishermen have not found it practicable to observe them. The Board's cruisers have instructions to warn foreign trawlers on all possible occasions of the presence of the cod-nets; and representations have from time to time been made to the Governments of the Countries concerned and have received sympathetic consideration. The North Sea Convention of 1882 does not specifically provide for cod-net fishing, but the position appears to be one which is covered in principle by Article XV of the Convention, which reads:—

> "Boats arriving on the fishing grounds shall not either place themselves or shoot their nets in such a way as to injure each other, or as to interfere with fishermen who have already commenced their operations."

It has been suggested that if trawlers would refrain during the concentration of cod-nets from trawling operations westwards of the line between Clythness and Covesea, which is easily distinguished by the lights at these terminal points, much of the difficulty would be removed. It is to be observed, however, that this line does not mark the limit of the cod-net grounds, considerable concentrations occurring for eight or nine miles further eastwards.

(5) Danish Seine Net Fishing.

Danish seine net fishing was first practised in Scottish waters in the autumn of 1921. It has developed mainly in the Moray Firth where it is now carried on by about 1,250 fishermen of whom nearly 600 belong to Buckie, about 300 to Findhorn, 200 to Banff, 150 to Fraserburgh, and 30 to Wick. About 20 fishermen from Lossiemouth use the Danish seine net all the year round, but for the great majority of the fishermen the fishing is at present a supplementary means of liveli-

hood carried on at intervals between the herring fishings. The principal period for Danish seine net fishing is the first four months of the year but the duration and extent of the fishing is determined to a large extent by the degree of success which has attended the herring fishings. Some of the fishermen fish on the Dogger Bank and elsewhere in the North Sea outside the Moray Firth and land their catches at Grimsby, Hull, Hartlepool and Shields. Others work on the West Coast of Scotland and in the Firth of Clyde from Mallaig, Oban, Ayr and Stranraer. Danish seine net fishing has not yet been long enough in operation in Scotland to enable any definite opinion to be formed as to its future development, but there appears to be a general consensus of opinion as to its efficiency as a method of fishing.

Two types of net are used, viz., (1) the Plaice Seine, and (2) the Haddock Seine, designed for the capture of flat fish and round fish respectively. The mesh of the plaice net is usually about 8 inches round, *i.e.* 2 inches from knot to knot, in the wings, and 6 inches round, $1^1/_2$ inches knot to knot, in the cod-end; and that of the haddock net is 10 inches round, $2^1/_2$ inches knot to knot, in the wings, and 7 inches round, $1^3/_4$ inches knot to knot, in the cod-end. In other respects the two types of net are similar. The total length of net is usually from 33 to 36 fathoms, the depth of net is from 6 to 7 fathoms, and the length of each hauling warp ranges from 750 to 1,000 fathoms, according to the depth of water on the fishing grounds.

In working the Danish seine net the ship's anchor, with the seine warp attached, is dropped and buoyed with a "dan". The ship then steams about 2 points off the tide, paying out warp as she goes. After paying out about 600 fathoms or more, according to depth, the ship turns at an inward angle so as to lay the last 100 fathoms of warp, the net, and a further 100 fathoms of warp across the tide. She then turns back to pick up the buoy, paying out warp at a sufficient speed to prevent any drag on the net. When she has been made fast to her moorings, both warps are attached to a special winch and are hauled in together. During the haul, the warps apparently act as "ticklers" stirring up the fish and shepherding them into the net. As the warps remain on the bottom during the process of hauling the mouth of the net is kept open until within 50 fathoms of the ship.

Catches by Danish seine net from the Moray Firth are landed mainly at Aberdeen and Lossiemouth. In 1926 the catches amounted to 28970 cwts of a value of £69894.

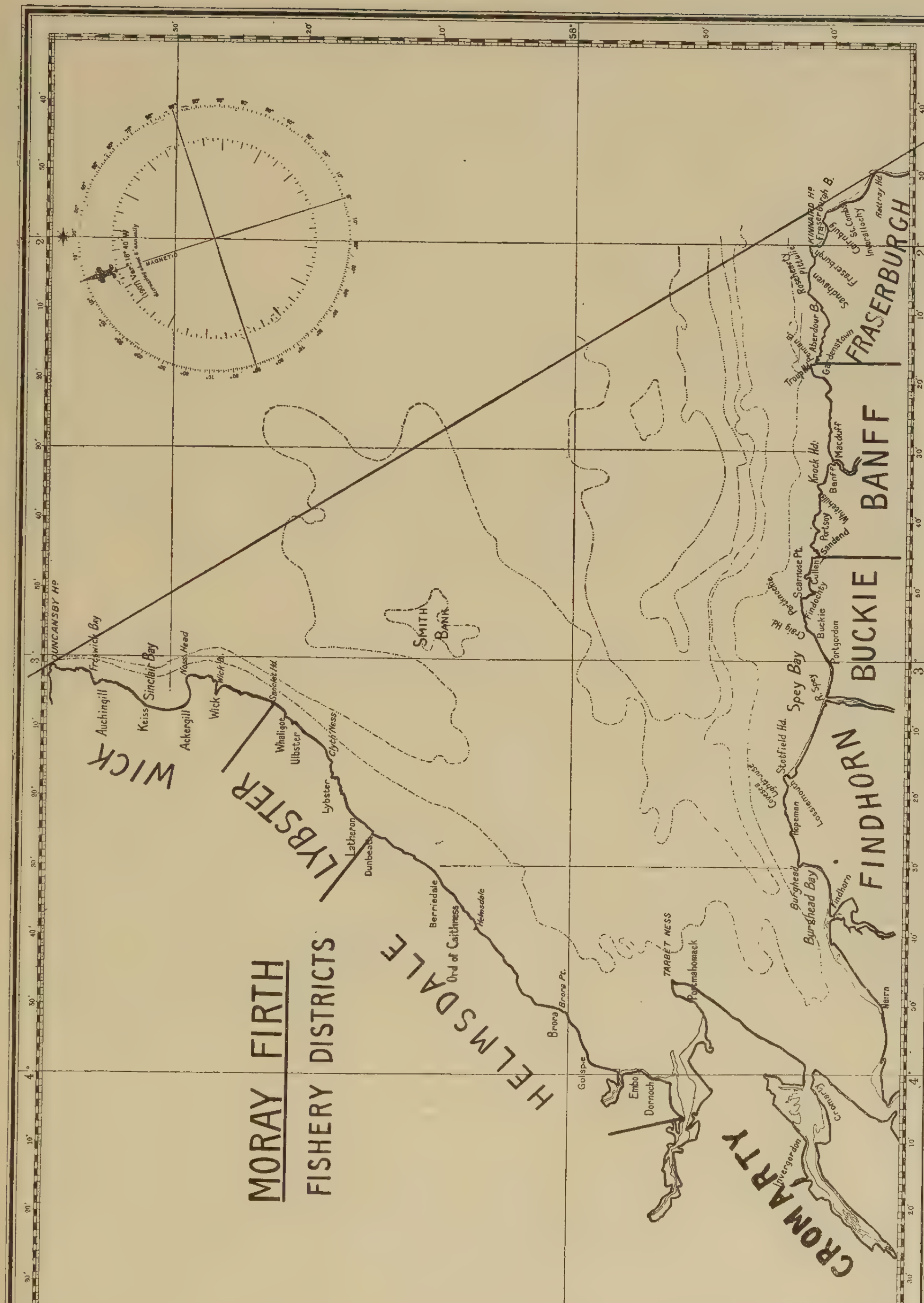
Plaice, lemon soles, cod, witches and haddock are the principal species caught in the Firth in the spring months; haddocks and sometimes hake figure more largely in the catches during the rest of the year. The nature and composition of the catches are examined in detail by Bowman in Paper No. 9.

The fishing grounds frequented by the Danish seine net vessels in the Moray Firth are scattered and are detailed by Bowman in Paper No. 9, but it may be stated here that for plaice the principal grounds lie in the inner portion of the Firth to the west of longitude 2°50′ W. From January to April the cod-net

and seine net fishermen work simultaneously in this area but practically no collisions between the two types of gear occur as the seine net vessels work principally in daylight and are generally familiar with the dispositions of the anchored cod-nets.

No powers exist for the regulation or control of seine net fishing within the Moray Firth outside the British exclusive fishery limits, but within the exclusive fishery limits the use of the Danish seine net is prohibited under a Byelaw of the Fishery Board for Scotland dated 7th December, 1898, forbidding the use by trailing or dragging along the bottom of the sea, of any net (including a seine or circle net) or other instrument for the capture of sea fish other than herrings, sprats, sparl ng, and shell fish. By subsequent Byelaws certain inshore areas — on the East Coast from Rattray Head to Fife Ness, in the Firths of Forth and Clyde, Luce Bay and on the East Coast of Shetland — have been opened to seine net fishing by small boats. The concession is subject to the conditions (1) that no otter boards are used, (2) that the boat used shall not exceed 40 feet in length of keel and shall not be propelled otherwise than by sails or oars or by a motor engine, (3) that in the working of the net only one boat shall be employed, (4) that the net shall be hauled in as soon as its ends have been brought together and shall not be otherwise dragged or trailed along the bottom of the sea, (5) that the net shall not exceed 200 yards in length, (6) that the mesh of the wings of the net shall not be less than 10 inches round and the mesh of any bag attached to the net shall not be less than 8 inches round, and (7) that no flat fish under 8 inches in length shall be landed.

Considerable advantage has been taken of this concession particularly in St. Andrews Bay and the Firth of Forth where considerable quantities of flat fish are taken. Requests for permission to use the seine net in the exclusive fishery limits of the Moray Firth have been made from time to time but have not been granted.


MORAY FIRTH
FISHERY DISTRICTS
WICK
LYBSTER
HELMSDALE
CROMARTY
FINDHORN
BUCKIE
BANFF
FRASERBURGH
SMITH BANK
Spey Bay
Burghead Bay
Sinclair Bay
TARBET NESS

Statement No. 1. **M**

Statement indicat

District	Limits	No. of Resident Fishermen	No. of Vessels			
			Steam	Motor	Sail	Tota
Fraserburgh	Rattray Head to Troup Head	1,689	96	129	259	48
Banff	Troup Head to Sandend	1,284	86	126	89	30
Buckie	Cullen to River Spey	3,117	279	54	118	45
Findhorn	River Spey to Inverness	1,351	111	79	8	19
Cromarty	Avoch to Dornoch Firth (North Shore)	404	1	29	93	12
Helmsdale	Dornoch (North Shore) to Dunbeath	264	—	51	61	11
Wick and Lybster	Latheron to Duncansby Head	563 (including 88 crofter fishermen)	21	55	83	15
	Total...	8,672	594	523	711	1,82

in 1925.

y and Value of Fish Landed				Principal Methods of Fishing	Remarks
	Other Kinds (except Shell Fish)		Value of Shell Fish		
£	Cwts.	£	£		
,825	24,421	32,087	1,610	Drift-net, great line, small line hand line, seine net, cod-net.	The landing of herrings are made largely by vessels from other centres temporarily working from Fraserburgh.
.431	27,470	41,815	376	Drift-net, small line, seine net, hand line, cod-net.	
.431	16,230	24,128	132	Drift-net, cod-net, seine net.	The fishermen usually engage in herring fishing from other centres; only a few landings are made locally.
669	36,028	50,559	524	Drift-net, seine net, small line, cod-net.	
320	18,652	19,555	1,161	Drift-net, small line, great line, hand line, cod-net.	
395	15,669	17,161	2,896	Drift-net, small line, hand line, cod-net.	
442	11,041	6,986	2,914	Drift-net, hand line, great line, small line, seine net, cod-net.	The landings of herrings are made mainly by vessels from other centres temporarily working from Wick.
513	149,511	192,291	9,613		

Statement No. 2.

Numbers and Nationalities of non-British Trawlers observed at work in the Moray Firth from 1896 to 1926.

Year	Norwegian		Swedish		German		French		Belgian		Dutch		Danish		Total	
	Number of trawlers observed	Number of occasions on which observed	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions
1896[1] ...	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
1897[1] ...	—	—	—	—	4	—	—	—	2	—	—	—	2	—	8	—
1898[1] ...	—	—	—	—	9	17	4	9	9	15	1	1	5	18	28	60
1899.....	3	21	—	—	23	41	5	15	10	26	2	8	6	43	49	154
1900.....	7	34	—	—	4	14	—	—	6	11	10	27	13	124	40	210
1901.....	14	97	—	—	2	5	—	—	3	5	2	3	6	26	27	136
1902.....	14	182	1	7	—	—	—	—	2	8	2	3	1	5	20	205
1903.....	13	156	1	8	—	—	—	—	8	23	1	2	—	—	23	189
1904.....	25	259	1	9	—	—	—	—	4	8	2	3	—	—	32	279
1905.....	28	277	—	—	—	—	—	—	1	1	—	—	1	1	30	279
1906.....	32	148	—	—	—	—	—	—	1	1	—	—	—	—	33	149
1907.....	17	178	1	3	1	2	—	—	6	18	—	—	—	—	25	201
1908.....	15	140	3	10	—	—	—	—	10	27	2	4	9	38	39	219
1909.....	10	74	3	10	1	1	—	—	7	16	5	6	16	106	42	213
1910.....	8	144	—	—	5	12	—	—	9	26	7	15	9	37	38	234
1911.....	8	115	2	13	22	44	—	—	6	9	11	15	1	11	50	207
1912.....	7	87	7	26	32	53	—	—	6	18	10	24	2	18	64	226
1913.....	6	115	1	4	11	18	—	—	7	21	13	30	4	46	42	234
1914.....	6	68	—	—	11	22	—	—	13	51	22	60	7	42	59	243
1915 1916 1917 1918 Nil.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1919.....	—	—	—	—	—	—	—	—	1	1	—	—	—	—	1	1
1920.....	—	—	—	—	1	1	—	—	11	31	5	7	—	—	17	39
1921.....	—	—	—	—	4	10	—	—	14	35	15	36	—	—	33	81
1922.....	—	—	—	—	4	6	—	—	6	14	1	2	—	—	11	22
1923.....	—	—	—	—	6	6	—	—	8	18	—	—	—	—	14	24
1924.....	—	—	—	—	4	5	—	—	9	13	—	—	—	—	13	18
1925.....	—	—	—	—	—	—	—	—	15	51	—	—	—	—	15	51
1926.....	—	—	—	—	2	3	—	—	13	34	7	16	—	—	22	53

[1] The figures given for these years are only approximate.

Statement No. 3.

Moray Firth Districts.

Statement for the years 1892—1925 showing for the various Districts of the Moray Firth the number of resident fishermen and boys.

Year	Fraser-burgh	Banff	Buckie	Findhorn	Cromarty	Helms-dale	Wick and Lybster (Latheron to Duncansby Head)	Total
1892	1248	1214	2266	1293	945	423	1696	9085
1893	1195	1206	2287	1310	948	429	1758	9133
1894	1223	1181	2287	1317	864	426	1612	8910
1895	1265	1171	2272	1334	810	426	1551	8829
1896	1304	1159	2298	1331	771	424	1543	8830
1897	1357	1173	2325	1334	755	423	1443	8810
1898	1364	1182	2322	1320	749	414	1416	8767
1899	1361	1187	2351	1324	770	413	1373	8779
1900	1542	1188	2395	1312	764	424	1307	8932
1901	1521	1190	2416	1324	752	431	1363	8997
1902	1535	1214	2433	1336	744	426	1375	9063
1903	1538	1225	2459	1357	756	438	1366	9139
1904	1570	1264	2533	1368	750	491	1298	9274
1905	1583	1279	2569	1388	730	464	1378	9391
1906	1614	1290	2682	1422	726	436	1356	9526
1907	1655	1300	2883	1515	721	424	1247	9745
1908	1702	1330	2846	1692	702	414	1029	9715
1909	1701	1371	2846	1714	696	387	926	9641
1910	1721	1401	2910	1705	673	371	894	9675
1911	1752	1425	2916	1654	653	377	803	9580
1912	1839	1435	2975	1650	636	366	743	9644
1913	1963	1440	3014	1630	619	365	710	9741
1914	1980	1457	3048	1635	614	360	680	9774
1915[1]	1212	482	592	425	213	175	200	3299
1916[1]	974	612	1056	415	230	170	225	3682
1917[1]	906	575	1358	455	210	190	90	3784
1918[1]	951	606	1390	550	232	195	85	4009
1919[1]	2020	1317	3369	1180	318	295	320	8819
1920	1969	1419	3935	1514	657	308	676	10478
1921	1973	1400	3639	1494	514	305	644	9969
1922	1817	1387	3607	1477	403	297	636	9624
1923	1711	1366	3292	1422	399	272	564	9126
1924	1703	1345	3133	1404	397	264	550	8796
1925	1689	1284	3117	1351	404	264	563	8672

[1] The figures for the years 1915—1919 represent the total number of fishermen actually engaged in fishing.

Statement No. 4.

Moray Firth.

Statement showing the number of steam, motor and sail fishing vessels in the Moray Firth Districts (Fraserburgh to Wick) during the years 1892 to 1925 inclusive.

All Districts.

Year	Steam	Fishing Vessels									Grand Total Steam, Motor and Sail
		Motor Vessels					Sail Vessels				
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	1	—	—	—	—	—	1893		652	793	3338	3339
1893...	1	—	—	—	—	—	1856		884	530	3270	3271
1894...	1	—	—	—	—	—	847	1000	646	738	3231	3232
1895...	2	—	—	—	—	—	918	930	681	730	3259	3261
1896...	5	—	—	—	—	—	981	887	672	866	3406	3411
1897...	5	—	—	—	—	—	1003	769	650	713	3135	3140
1898...	3	—	—	—	—	—	1043	709	640	713	3105	3108
1899...	13	—	—	—	—	—	1107	660	573	692	3032	3045
1900...	21	—	—	—	—	—	1194	597	557	662	3010	3031
1901...	30	—	—	—	—	—	1257	510	518	656	2941	2971
1902...	34	—	—	—	—	—	1332	442	499	659	2932	2966
1903...	71	—	—	—	—	—	1359	368	464	646	2837	2908
1904...	110	—	—	—	—	—	1383	275	465	675	2798	2908
1905...	116	—	—	—	—	—	1341	212	457	681	2691	2807
1906...	162	—	—	—	—	—	1303	161	435	696	2595	2757
1907...	306	—	—	—	—	—	1180	115	426	667	2388	2694
1908...	379	—	—	—	—	—	1084	90	423	665	2262	2641
1909...	406	22	—	—	—	22	992	65	420	659	2136	2564
1910...	461	26	—	—	—	26	954	55	425	630	2064	2551
1911...	516	28	—	2	—	30	851	39	419	620	1929	2475
1912...	549	33	3	12	4	52	777	42	422	629	1870	2471
1913...	600	50	19	21	8	98	693	27	402	618	1740	2438
1914...	662	74	23	47	8	152	585	21	397	613	1616	2430
1915...	657	64	20	57	8	149	581	25	390	646	1642	2448
1916...	633	113	27	77	13	230	504	27	340	628	1499	2362
1917...	632	188	37	116	15	356	428	19	296	633	1376	2364
1918...	627	263	46	183	28	520	315	8	234	611	1168	2315
1919...	578	353	57	223	49	682	91	6	199	571	867	2127
1920...	589	349	63	240	41	693	54	3	164	605	826	2108
1921...	573	321	73	249	48	691	43	2	154	622	821	2085
1922...	566	294	82	243	55	674	29	2	146	609	786	2026
1923...	559	250	79	240	55	624	20	1	136	589	746	1929
1924...	568	208	72	224	54	558	15	1	127	585	728	1854
1925...	594	184	66	221	52	523	12	1	113	587	711	1828

Statement No. 5.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Fraserburgh District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	1	—	—	—	—	—	278		109	269	656	657
1893...	1	—	—	—	—	—	260		345		605	606
1894...	1	—	—	—	—	—	122	144	81	270	617	618
1895...	1	—	—	—	—	—	148	129	86	280	643	644
1896...	1	—	—	—	—	—	159	126	96	286	667	668
1897...	1	—	—	—	—	—	180	110	125	272	687	688
1898...	2	—	—	—	—	—	204	99	123	272	698	700
1899...	8	—	—	—	—	—	188	103	55	253	599	607
1900...	11	—	—	—	—	—	197	89	48	248	582	593
1901...	10	—	—	—	—	—	216	72	39	236	563	573
1902...	10	—	—	—	—	—	239	58	32	245	574	584
1903...	10	—	—	—	—	—	263	50	27	250	590	600
1904...	11	—	—	—	—	—	274	34	38	254	600	611
1905...	11	—	—	—	—	—	269	23	36	263	591	602
1906...	12	—	—	—	—	—	272	20	27	274	593	605
1907...	34	—	—	—	—	—	257	20	27	267	571	605
1908...	48	—	—	—	—	—	239	22	32	275	568	616
1909...	45	11	—	—	—	11	236	21	33	273	563	619
1910...	49	11	—	—	—	11	229	17	32	263	541	601
1911...	53	11	—	—	—	11	216	11	28	255	510	574
1912...	65	11	—	—	—	11	207	17	22	264	510	586
1913...	86	16	2	—	—	18	185	15	17	272	489	593
1914...	100	22	6	1	—	29	152	7	19	263	441	570
1915...	98	22	14	2	—	38	152	4	18	272	446	582
1916...	97	56	19	2	—	77	120	5	14	270	409	583
1917...	100	91	18	3	—	112	107	5	12	275	399	611
1918...	98	127	17	6	1	151	51	—	6	270	327	576
1919...	84	141	14	16	9	180	6	—	2	231	239	503
1920...	87	134	15	35	9	193	1	—	4	244	249	529
1921...	85	117	13	41	12	183	—	—	2	261	263	531
1922...	83	111	13	42	13	179	—	—	2	264	266	528
1923...	74	96	12	41	14	163	—	—	2	266	268	505
1924...	77	79	10	32	13	134	—	—	2	263	265	476
1925...	94	69	9	38	13	129	—	—	2	257	259	482

Statement No. 6.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Banff District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	212		138	137	487	487
1893...	—	—	—	—	—	—	204		140	130	474	474
1894...	—	—	—	—	—	—	103	92	136	105	436	436
1895...	—	—	—	—	—	—	112	89	141	99	441	441
1896...	—	—	—	—	—	—	113	89	127	116	445	445
1897...	—	—	—	—	—	—	116	87	129	117	449	449
1898...	—	—	—	—	—	—	124	87	134	122	467	467
1899...	—	—	—	—	—	—	140	85	133	118	476	476
1900...	—	—	—	—	—	—	151	73	129	110	463	463
1901...	—	—	—	—	—	—	153	67	119	98	437	437
1902...	—	—	—	—	—	—	163	59	112	99	433	433
1903...	3	—	—	—	—	—	171	49	105	99	424	427
1904...	7	—	—	—	—	—	173	38	105	103	419	426
1905...	7	—	—	—	—	—	171	35	107	112	425	432
1906...	14	—	—	—	—	—	169	24	103	111	407	421
1907...	34	—	—	—	—	—	150	15	103	114	382	419
1908...	38	—	—	—	—	—	147	15	98	111	371	409
1909...	44	3	—	—	—	3	139	17	109	107	372	416
1910...	58	4	—	—	—	4	131	14	105	110	360	422
1911...	79	4	—	—	—	4	119	13	106	108	346	429
1912...	86	8	—	—	—	8	103	11	101	104	319	413
1913...	93	3	2	13	—	18	92	10	91	95	288	399
1914...	100	5	1	31	—	37	79	10	75	93	257	394
1915...	98	4	3	31	—	38	75	8	70	97	250	387
1916...	92	7	5	40	—	52	60	8	56	94	218	363
1917...	90	17	9	50	—	76	42	6	41	95	184	350
1918...	90	24	13	62	2	101	28	4	29	88	149	340
1919...	85	27	18	77	5	127	16	2	21	81	120	332
1920...	86	41	24	64	3	132	7	—	6	80	93	311
1921...	82	40	27	65	3	135	6	—	3	84	93	310
1922...	78	36	33	66	5	140	2	—	3	81	86	306
1923...	81	35	34	63	5	137	2	—	4	82	88	306
1924...	80	32	36	60	5	133	2	—	4	83	89	302
1925...	86	28	36	57	5	126	1	—	4	84	89	301

Statement No. 7.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Buckie District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	574		79	103	756	756
1893...	—	—	—	—	—	—	595		92	101	788	788
1894...	—	—	—	—	—	—	309	298	115	99	821	821
1895...	—	—	—	—	—	—	331	263	135	89	818	818
1896...	—	—	—	—	—	—	360	222	126	84	792	792
1897...	—	—	—	—	—	—	376	184	114	70	744	744
1898...	—	—	—	—	—	—	375	151	101	66	693	693
1899...	1	—	—	—	—	—	418	124	107	70	719	720
1900...	1	—	—	—	—	—	447	107	121	58	733	734
1901...	1	—	—	—	—	—	470	97	122	48	737	738
1902...	12	—	—	—	—	—	474	82	119	48	723	735
1903...	30	—	—	—	—	—	467	68	114	36	685	715
1904...	54	—	—	—	—	—	489	31	103	30	653	707
1905...	60	—	—	—	—	—	470	15	104	28	617	677
1906...	93	—	—	—	—	—	442	8	105	32	587	680
1907...	168	—	—	—	—	—	401	8	104	29	542	710
1908...	208	—	—	—	—	—	368	5	98	27	498	706
1909...	219	—	—	—	—	—	327	—	91	30	448	667
1910...	236	—	—	—	—	—	320	3	91	32	446	682
1911...	247	—	—	—	—	—	310	3	94	31	438	685
1912...	257	—	—	—	—	—	286	3	107	33	429	686
1913...	276	—	—	—	—	—	272	5	100	45	422	698
1914...	298	—	—	—	—	—	239	4	102	51	396	694
1915...	298	12	—	—	—	12	225	4	101	49	379	689
1916...	293	28	—	—	—	28	207	4	97	38	346	667
1917...	295	53	—	1	—	54	183	—	97	38	318	667
1918...	295	71	—	4	—	75	162	—	95	41	298	668
1919...	277	123	—	4	5	132	39	—	84	71	194	603
1920...	287	119	5	4	2	130	26	—	71	77	174	591
1921...	274	112	7	4	3	126	22	—	75	73	170	570
1922...	271	93	11	3	5	112	17	—	69	66	152	535
1923...	272	75	7	4	2	88	12	—	61	64	137	497
1924...	276	55	2	2	2	61	9	—	56	59	124	461
1925...	279	50	1	1	2	54	7	—	45	66	118	451

Statement No. 8.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Findhorn District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	145	117	112	14	388	388
1893...	—	—	—	—	—	—	145	104	109	14	372	372
1894...	—	—	—	—	—	—	163	104	101	16	384	384
1895...	—	—	—	—	—	—	166	114	117	18	415	415
1896...	—	—	—	—	—	—	166	112	110	18	406	406
1897...	—	—	—	—	—	—	173	110	113	17	413	413
1898...	—	—	—	—	—	—	177	98	116	16	407	407
1899...	1	—	—	—	—	—	193	97	107	16	413	414
1900...	1	—	—	—	—	—	227	79	91	16	413	414
1901...	1	—	—	—	—	—	239	71	77	17	404	405
1902...	3	—	—	—	—	—	254	58	75	15	402	405
1903...	10	—	—	—	—	—	254	39	72	17	382	392
1904...	12	—	—	—	—	—	249	33	76	23	381	393
1905...	13	—	—	—	—	—	242	22	78	24	366	379
1906...	19	—	—	—	—	—	224	15	75	24	338	357
1907...	45	—	—	—	—	—	197	18	63	21	299	344
1908...	62	—	—	—	—	—	190	8	61	24	283	345
1909...	75	—	—	—	—	—	180	4	60	24	268	343
1910...	95	4	—	—	—	4	160	2	69	19	250	349
1911...	114	4	—	—	—	4	111	1	68	21	201	319
1912...	119	4	—	—	—	4	93	2	73	20	188	311
1913...	122	5	3	—	—	8	82	1	72	16	171	301
1914...	132	5	5	1	—	11	70	1	75	21	167	310
1915...	130	5	3	1	—	9	63	1	83	36	183	322
1916...	128	3	3	11	1	18	56	1	76	31	164	310
1917...	128	6	7	30	3	46	43	—	57	32	132	306
1918...	126	10	14	55	10	89	36	—	30	32	98	313
1919...	115	27	19	60	10	116	8	1	13	20	42	273
1920...	112	22	18	55	6	101	4	—	12	17	33	246
1921...	115	20	22	61	7	110	2	—	8	15	25	250
1922...	114	21	23	58	7	109	2	—	7	17	26	249
1923...	113	15	22	56	9	102	—	—	8	4	12	227
1924...	114	14	22	55	9	100	—	—	6	1	7	221
1925...	111	9	19	44	7	79	—	—	7	1	8	198

Statement No. 9.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Cromarty District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	122		115	66	303	303
1893...	—	—	—	—	—	—	120		110	68	298	298
1894...	—	—	—	—	—	—	13	110	105	58	286	286
1895...	—	—	—	—	—	—	17	107	102	56	282	282
1896...	—	—	—	—	—	—	18	102	94	62	276	276
1897...	—	—	—	—	—	—	19	95	89	65	268	268
1898...	—	—	—	—	—	—	20	91	85	66	262	262
1899...	—	—	—	—	—	—	20	81	92	66	259	259
1900...	—	—	—	—	—	—	21	82	88	59	250	250
1901...	—	—	—	—	—	—	31	37	81	85	234	234
1902...	—	—	—	—	—	—	37	33	86	77	233	233
1903...	—	—	—	—	—	—	38	33	72	77	220	220
1904...	—	—	—	—	—	—	40	23	70	83	216	216
1905...	—	—	—	—	—	—	35	13	65	88	201	201
1906...	—	—	—	—	—	—	35	7	60	90	192	192
1907...	—	—	—	—	—	—	34	4	62	92	192	192
1908...	—	—	—	—	—	—	34	4	70	89	197	197
1909...	—	—	—	—	—	—	33	2	71	87	193	193
1910...	—	—	—	—	—	—	34	2	72	84	192	192
1911...	—	—	—	—	—	—	25	—	68	75	168	168
1912...	—	—	—	—	—	—	22	—	67	68	157	157
1913...	—	—	—	—	—	—	19	—	63	63	145	145
1914...	—	—	—	—	—	—	19	—	62	60	141	141
1915...	—	—	—	—	—	—	19	—	63	59	141	141
1916...	—	—	—	—	—	—	18	—	54	56	128	128
1917...	—	—	—	—	—	—	15	—	48	56	119	119
1918...	—	—	—	3	—	3	13	—	43	54	110	113
1919...	—	—	—	5	5	10	8	—	50	38	96	106
1920...	1	—	—	17	—	17	7	—	46	47	100	118
1921...	1	—	—	20	—	20	7	—	45	44	96	117
1922...	1	—	—	19	—	19	5	—	44	46	95	115
1923...	1	—	—	23	—	23	5	—	43	41	89	113
1924...	1	—	—	21	—	21	4	—	41	50	95	117
1925...	1	—	1	27	1	29	3	—	38	52	93	123

Statement No. 10.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Helmsdale District.

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	11	94	49	46	200	200
1893...	—	—	—	—	—	—	11	96	53	45	205	205
1894...	—	—	—	—	—	—	11	91	54	42	198	198
1895...	—	—	—	—	—	—	11	91	53	42	197	197
1896...	—	—	—	—	—	—	12	92	53	42	199	199
1897...	—	—	—	—	—	—	13	92	51	39	195	195
1898...	—	—	—	—	—	—	15	93	51	39	198	198
1899...	—	—	—	—	—	—	15	90	54	38	197	197
1900...	1	—	—	—	—	—	14	92	59	35	200	201
1901...	1	—	—	—	—	—	14	92	59	34	199	200
1902...	1	—	—	—	—	—	19	79	54	36	188	189
1903...	3	—	—	—	—	—	19	66	53	33	171	174
1904...	9	—	—	—	—	—	18	56	52	32	188	167
1905...	9	—	—	—	—	—	17	47	46	33	143	152
1906...	9	—	—	—	—	—	19	35	45	34	133	142
1907...	9	—	—	—	—	—	20	21	45	32	118	127
1908...	9	—	—	—	—	—	19	14	45	35	113	122
1909...	9	—	—	—	—	—	18	9	41	39	107	116
1910...	9	—	—	—	—	—	17	7	41	39	104	113
1911...	9	1	—	—	—	1	15	4	42	54	115	125
1912...	9	1	—	1	—	2	14	2	42	58	116	127
1913...	9	1	—	1	—	2	11	2	42	55	110	121
1914...	9	2	—	2	—	4	11	2	47	56	116	129
1915...	8	2	—	3	—	5	11	2	47	56	116	129
1916...	4	2	—	10	2	14	10	2	40	55	107	125
1917...	3	1	—	13	1	15	8	1	38	53	100	118
1918...	3	2	—	21	2	25	5	—	30	45	80	108
1919...	3	2	—	30	4	36	5	—	26	44	75	114
1920...	1	2	—	35	4	41	5	—	24	50	79	121
1921...	—	1	3	34	7	45	4	—	20	51	75	120
1922...	—	1	1	33	9	44	2	—	20	46	68	112
1923...	—	1	3	35	9	48	—	—	17	46	63	111
1924...	—	2	2	37	9	50	—	—	17	44	61	111
1925...	—	4	1	38	8	51	—	—	17	44	61	112

Statement No. 11.

Moray Firth.

Statement showing the number of District Fishing Boats, distinguishing each class, for each of the years 1892 to 1925.

Wick and Lybster District (Latheron to Duncansby Head).

Year	Steam Vessels	Motor Vessels					Sail Vessels					Grand Total
		45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Motor	45 feet keel and upwards	30 to 45 feet keel	18 to 30 feet keel	Under 18 feet keel	Total Sail	
1892...	—	—	—	—	—	—	340		50	158	548	548
1893...	—	—	—	—	—	—	321		58	149	528	528
1894...	—	—	—	—	—	—	126	161	54	148	489	489
1895...	1	—	—	—	—	—	133	137	47	146	463	464
1896...	3	—	—	—	—	—	144	133	42	142	461	464
1897...	3	—	—	—	—	—	126	91	29	133	389	392
1898...	—	—	—	—	—	—	128	90	30	132	380	380
1899...	3	—	—	—	—	—	132	80	25	131	368	371
1900...	4	—	—	—	—	—	139	75	21	136	371	375
1901...	8	—	—	—	—	—	142	74	21	138	375	383
1902...	8	—	—	—	—	—	146	73	21	139	379	387
1903...	15	—	—	—	—	—	147	63	21	134	365	380
1904...	17	—	—	—	—	—	140	60	21	134	355	372
1905...	16	—	—	—	—	—	137	57	21	115	330	346
1906...	13	—	—	—	—	—	142	52	20	131	245	258
1907...	14	—	—	—	—	—	120	34	19	111	284	298
1908...	14	—	—	—	—	—	91	16	19	83	210	224
1909...	14	—	—	—	—	—	78	12	15	99	204	218
1910...	14	—	—	—	—	—	70	10	15	93	188	202
1911...	14	—	—	—	—	—	63	7	15	93	178	192
1912...	13	—	—	—	—	—	62	10	21	85	178	191
1913...	14	—	—	—	—	—	57	8	22	80	167	181
1914...	23	—	—	—	—	—	56	7	29	77	169	192
1915...	23	17	—	13	9	39	37	6	8	77	128	190
1916...	18	17	—	14	10	41	33	7	3	84	127	185
1917...	16	20	2	20	11	53	30	7	3	84	124	197
1918...	15	29	2	32	13	76	20	4	2	80	106	197
1919...	14	33	2	30	16	81	9	3	3	86	101	196
1920...	15	31	1	30	17	79	4	3	1	90	98	192
1921...	16	31	1	24	16	72	2	2	1	94	99	187
1922...	17	32	1	22	16	71	1	2	1	89	93	181
1923...	18	28	1	18	16	63	1	1	1	86	89	170
1924...	20	26	—	17	16	59	—	1	1	85	87	166
1925...	21	22	1	16	16	55	—	1	—	82	83	159

Statement No. 12.

Moray Firth.

Statement showing the Quantity and Value of the Different Kinds of Demersal Fish landed in the various districts of the Moray Firth during the year 1925.

District	Haddocks		Cod and Codling		Plaice		Lemon Soles		Whitings		Skates and Rays		Hake		Saithe		Witches		Ling	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh	3.278	4.160	7.636	7.680	484	1.996	1.611	8.072	332	267	1.743	1.483	2.485	2.432	687	351	758	1.328	665	423
Banff	17.931	22.990	5.454	5.047	588	2.097	2.322	10.748	803	533	92	48	5	11	6	2	48	117	49	40
Buckie	1.355	1.819	12.325	13.851	1.363	5.408	415	2.121	25	16	287	197	59	93	32	19	69	196	1	1
Findhorn	20.656	21.384	4.326	5.031	3.899	15.230	755	3.749	2.012	1.186	640	309	959	997	..	..	514	1.349	19	17
Cromarty	12.265	13.072	3.598	3.160	792	1.521	2	12	934	578	345	256	45	111	142	114	..	..	..	..
Helmsdale	11.989	13.936	2.991	2.434	298	568	..	..	384	207	..	..	..	..	..	..	..	..	..	..
Wick & Lybster.	5.462	3.883	12 960	10.410	148	288	2	11	..	..	962	715	60	68	579	159	..	..	306	177
(Latheron to Cape Wrath[1])																				
Total...	72.936	81.244	49.290	47.613	7.572	27.108	5.107	24.713	4.490	2.787	4.069	3.008	3.613	3.712	1.446	645	1.389	2.990	1.040	658

District	Monks (Anglers)		Halibut		Megrims		Dabs		Catfish		Conger Eels		Flounders		Gurnards		Brill		Torsk		Turbot		Unclassified Kinds		Total Demersal Fish	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh	250	117	200	652	351	443	79	169	98	32	167	86	..	..	9	4	..	..	14	6	2	6	11	4	20.860	29.711
Banff	27	11	24	82	1	2	7	5	51	21	..	..	..	..	2	1	15	45	2	1	..	..	..	..	27.427	41.801
Buckie	50	40	13	68	13	35	..	..	2	1	7	5	..	..	..	..	13	51	..	..	1	4	158	191	16.188	24.116
Findhorn	331	188	15	72	12	29	40	27	156	71	14	8	10	10	..	..	16	92	..	..	12	61	..	..	34.386	49.810
Cromarty	..	..	..	..	..	..	212	268	..	..	..	..	115	153	2	2	..	..	..	..	..	..	167	275	18.619	19.522
Helmsdale	..	..	3	14	..	..	..	..	..	..	4	2	..	..	..	..	..	..	..	..	..	..	..	..	15.669	17.161
Wick & Lybster.	..	..	163	625	..	..	..	..	..	..	88	49	70	48	38	17	..	..	..	..	..	..	..	..	20.838	16.450
(Latheron to Cape Wrath[1])																										
Total...	658	356	418	1.513	377	509	338	469	307	125	280	150	195	211	51	24	44	188	16	7	15	71	336	470	153.987	198.571

[1] Landings of Demersal Fish from Duncansby Head to Cape Wrath amounted in 1925 to 11.402 cwts., valued at £ 9.676. With the exception of these landings and a proportion of the landings in the Fraserburgh District, practically all the above-mentioned quantities of fish were caught in the Moray Firth.

In addition, in 1925 Moray Firth Danish seine net vessels landed from the Firth at Aberdeen 1530 cwts. of flat fish valued at £ 6546 and 1493 cwts. of round fish valued at £ 1410.

Statement No. 13.

Moray Firth.

Statement showing the Quantities of the principal kinds of (1) Round Fish and (2) Flat Fish, and also the Total Quantities of (1) Round Fish and (2) Flat Fish landed by net or line boats (excluding trawlers) in the Moray Firth districts (Fraserburgh to Wick) from 1892 to 1925 inclusive.

Year	Cod	Haddocks	Total Quantity of Round Fish	Flounders, Plaice, Brill and Dabs	Total Quantity of Flat Fish
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
1892.....	93,076	184,699	325,378	6,712	9,711
1893.....	53,678	160,991	250,651	5,917	11,120
1894.....	54,219	205,253	299,291	6,978	10,534
1895.....	72,425	229,981	334,404	7,081	9,874
1896.....	93,717	206,537	334,624	4,488	6,377
1897.....	118,162	167,334	321,138	5,427	7,500
1898.....	87,679	104,701	226,332	5,000	6,681
1899.....	81,440	80,265	189,022	6,793	8,578
1900.....	56,791	60,326	142,186	6,260	7,664
1901.....	53,350	43,227	114,711	5,468	7,081
1902.....	46,671	52,838	114,057	5,990	6,997
1903.....	40,260	61,020	112,300	6,347	6,841
1904.....	52,102	75,009	141,257	9,048	9,750
1905.....	58,303	58,818	131,996	7,643	8,384
1906[1]	47,833	72,968	133,103	7,031	7,814
1907.....	46,767	81,870	138,794	7,796	8,306
1908.....	58,020	65,407	140,183	9,002	9,933
1909.....	79,178	39,285	124,588	6,344	6,930
1910.....	121,703	47,809	177,055	7,554	7,778
1911.....	94,711	77,446	180,979	7,947	8,573
1912.....	140,655	74,934	227,954	7,327	8,111
1913.....	99,095	39,849	150,150	6,543	7,386
1914.....	79,703	40,739	136,827	4,755	5,281
1915.....	68,767	66,564	148,922	5,007	6,088
1916.....	80,090	61,030	153,150	6,559	6,830
1917.....	81,637	62,292	154,870	5,028	5,887
1918.....	88,381	107,450	218,429	3,471	4,702
1919.....	102,929	102,415	220,649	3,397	5,027
1920.....	94,460	77,778	184,811	4,783	6,472
1921[2]	98,749	82,353	202,447	11,992	14,622
1922.....	75,867	79,303	176,988	12,435	22,205
1923.....	60,741	60,457	142,874	7,393	17,243
1924.....	49,768	48,276	113,711	6,828	14,557
1925.....	49,276	72,847	134,009	8,147	15,442

Note:- The above figures include relatively small landings in that part of the Wick district outside the Moray Firth extending from Duncansby Head to Cape Wrath.

[1] Cod-net fishing commenced in the Firth in 1906.

[2] Danish seine net fishing commenced in the Firth in September, 1921.

Statement No. 14.

Moray Firth.

All Districts (Fraserburgh to Wick).

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	5816	8246	2371	2648	1	—	1	—	9911	17422	4242	3622	3514	10129	2371	174
Small & Hand Line	39637	36334	26450	30230	74756	52299	39320	68669	130679	88932	72117	105208	3332	1637	1759	254
Cod Net ...	28964	24264	16634	13824	—	—	—	—	29495	24606	16889	13860	270	569	134	1
Danish Seine	2725	1897	4313	2574	4752	8158	8955	4178	8696	12914	21553	11319	18173	12234	12530	1287

Statement No. 15.

Moray Firth.

Fraserburgh District.

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	2659	4727	547	358	1	—	1	—	5694	12139	1606	1173	2676	9269	2066	1614
Small and Hand Line	10938	18107	7339	6351	3328	3423	2088	2517	18354	13267	11823	9922	1086	251	113	118
Cod Net ...	1284	499	1131	601	—	—	—	—	1435	628	1253	605	—	—	—	—
Danish Seine	—	126	186	325	31	1495	1163	754	32	2553	3866	3913	83	2419	2984	3495

Statement No. 16.

Moray Firth.

Banff District.

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1293	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	174	56	5	8	—	—	—	—	485	221	23	21	29	13	8	22
Small and Hand Line	5135	4378	5430	4684	18821	15761	12679	17184	29329	23554	20048	22709	24	71	20	61
Cod Net ...	1549	1398	1270	679	—	—	—	—	1577	1398	1300	679	142	472	106	—
Danish Seine	146	89	150	80	125	54	1257	683	358	177	1697	840	1731	1996	3258	2913

Statement No. 17.

Moray Firth.

Buckie District.

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	33	22	5	4	—	—	—	—	161	119	6	5	64	36	5	—
Small and Hand Line	4727	3107	2882	2211	3605	1341	338	1187	8807	4921	3269	3430	237	97	23	93
Cod Net ...	17234	16409	10829	9769	—	—	—	—	17547	16618	10882	9801	95	86	28	13
Danish Seine	1877	591	356	341	3406	2474	821	168	6039	3529	1713	620	9961	2323	2179	1781

Statement No. 18.

Moray Firth.

Findhorn District.

Quantity of Fish of certain descriptions, taken by particular methods of capture landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	41	634	135	—	—	—	—	—	184	1304	695	14	17	49	19	—
Small and Hand Line	2180	1387	728	1635	21439	14355	7806	18083	26315	17478	9831	21650	787	518	497	587
Cod Net ...	5369	3951	2326	873	—	—	—	—	5404	3955	2376	873	—	9	—	—
Danish Seine	701	1091	3621	1818	1188	4133	5714	2573	2264	6653	14277	5936	6393	5488	4109	4686

Statement No. 19.

Moray Firth.

Cromarty District.

Quantity of Fish of certain descriptions, taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	—	—	—	56	—	—	—	—	—	—	—	56	—	—	—	—
Small and Hand Line	2746	1296	2007	3368	10073	4795	5695	12265	13113	6407	7824	16756	490	415	606	1121
Cod Net ...	274	226	65	174	—	—	—	—	274	226	65	174	—	—	—	—
Danish Seine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Statement No. 20.

Moray Firth.

Helmsdale District.

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	297	107	19	2	—	—	—	—	491	212	32	6	95	102	21	3
Small and Hand Line	2299	2579	1594	1895	12442	9342	6570	11989	15466	12690	8317	14268	384	138	328	298
Cod Net ...	1567	981	743	1094	—	—	—	—	1567	981	743	1094	20	—	—	—
Danish Seine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Statement No. 21.

Moray Firth.

Wick and Lybster District.

Quantity of Fish of certain descriptions taken by particular methods of capture, landed in each of the years 1922—1925.

Description of Fish	Cod				Haddock				Total Round Fish (excluding pelagic)				Total Flat Fish			
Year	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
Method of Capture:	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Great Line.	2612	2700	1660	2220	—	—	—	—	2896	3427	1880	2347	633	660	252	109
Small and Hand Line	11612	5480	6470	10086	5048	3292	4144	5444	19295	9615	11005	16473	324	147	174	269
Cod Net ...	1687	800	270	634	—	—	—	—	1691	800	270	634	13	2	—	—
Danish Seine	1	—	—	10	2	2	—	—	3	2	—	10	5	8	—	2

Statement No. 22.

FISHERY BOARD FOR SCOTLAND.

COD NET FISHING IN MORAY FIRTH.

Regulations as to the Marking and Lighting of Anchored Cod Nets.

The following regulations relating to the marking and lighting of **Anchored Cod Nets,** and the lighting of vessels attendant thereon, have been drawn up by the Fishery Board for Scotland with a view to preventing damage to the nets, and have been approved by the Board of Trade.

I. At each end of each fleet of anchored cod nets, and at a point midway between the ends, there shall be fixed a buoy or dan, having a pole or mast at least nine feet high, carrying, during daylight, a dark-coloured flag at least one yard square in size; and at night, a lantern showing a fixed white light all round the horizon, visible at a distance of at least two miles.

II. Vessels lying at anchor in attendance on cod nets shall show the light prescribed for vessels at anchor.

III. Vessels in attendance on anchored cod nets shall indicate to any approaching trawler the side or end on which it is clear to pass, during daylight by waving a flag, and during darkness by showing a flare-light, the flag or flare-light being shown at the side or end of the anchored vessel farthest away from the nets.

David T. Jones.
Secretary.

EDINBURGH, 2*nd January* 1914.

Paper No. 2.

The Moray Firth.

Physical Characteristics

by

A. Bowman, D. Sc.

The Moray Firth may be defined geographically as that triangularly shaped part of the north-western North Sea bounded by the converging coast lines Duncansby Head—Inverness and Kinnaird Head—Inverness with the imaginary line Duncansby Head—Kinnaird Head as base. The region has an area of approximately 2,020 geographical square miles. The physical conditions of this area vary considerably, but there is a more or less gradual transition from the open sea conditions on the outer limits to the typical coastal conditions and to the estuarine conditions in the inner parts of the Firth.

The general conditions with respect to depth may best be seen from the bathymetric chart (p. 41). If the bed of the Moray Firth were raised 30 fathoms the whole of the area within the line Clyth Ness—Lossiemouth would become uncovered and the outer part of the Firth would be divided into two by a broad, low and sandy promontory extending in a north-easterly direction beyond Smith Bank.

Various types of bottom occur within the Firth and for conciseness of description these have been grouped in the following three categories (a) rock, stone and gravel (b) sand, and sand with only a small admixture of mud and (c) mud and muddy sand. Their distribution and extent as indicated in the accompanying chart are based on the British Admiralty Survey Charts and on the results of investigations with the Petersen Bottom Sampler.

There is no need to describe the coastal region in detail as its character follows more or less closely that of the contiguous shore. This belt is the area in which conditions vary most since wind, tide and current have here their maximum effect. Along the south shore westwards from Kinnaird Head the bottom, shelving moderately rapidly into the offshore deeper water, is rocky, interspersed here and there with patches of sand and gravel. There are extensive stretches of fine sand, especially in such shallow bays as Spey Bay, Burghead and Nairn Bays and Dornoch Firth. Along the north-west coast from Noss Head to Clyth Ness the shore

is rocky and precipitous. There is a luxuriant growth of Laminaria and other seaweeds on the rocky and precipitous coasts.

The coastal zone of less than 30 fathoms depth is of varying breadth. At its eastern boundary on the south coast it coincides approximately with the three-mile limit, but extends somewhat further seawards towards the west. On the north-west coast it is narrow and precipitous and between Noss Head and Clyth Ness depths of 30 fathoms are found within two miles of the shore.

The floor of the Moray Firth of less than 30 fathoms depth is of varied character, being composed mainly of muddy sand with extensive areas of rocky and sandy ground. Towards the apex of the Moray Firth triangle there is a gradual transition to the estuarine conditions of the Inverness Firth with its bottom deposits of heavy mud. Large stretches of muddy sand with the admixture of mud increasing with depth extend seaward for a considerable distance in the neighbourhood of Burghead and Nairn and in the Dornoch Firth, while in the vicinity of Lossiemouth the bottom is composed of very clean dust-fine sand. The rocky promontory of Tarbet Ness can be traced some distance seaward by the rocky nature of the sea floor. At Kinnaird and Rattray Head where the floor is scoured by strong tides and currents the usual mobile bottom-dwelling forms are either absent or find shelter amongst the masses of *Filigrana* and *Sabellaria* which occur there in great quantity. From Brora northwards to Berriedale and Clyth Ness the bottom is of muddy sand of somewhat uniform texture.

On the shallow promontory extending in the direction of Smith Bank the character of the bottom may also be described as sandy mud with comminuted shell fragments but it becomes less muddy seawards. In the shallowest parts of this promontory where depths of less than 20 fathoms occur — usually termed Smith Bank — there are a few rocky outcrops which are probably a continuation of the Caithness Flags. On the northern edge of Smith Bank the bottom is made up chiefly of hard sand with comminuted shells similar in texture to that found to the east of Orkney, whilst to the south-east of the Bank the ground gradually assumes the character of sandy mud similar to that found on the seaward border of the Moray Firth.

The southern deep valley may be defined as the area over 40 fathoms in depth. This is approximately rectangular in shape with an average breadth of about ten miles and it penetrates the southern portion of the Firth as far as Longitude 3°10′ W. Westwards of this line it narrows rapidly and is continued as a finger-like extension not more than two miles broad with depths of more than 30 fathoms, which runs parallel to the coast as far westwards as Burghead. Its deepest parts are found along the southern border where the core of the valley extends as a deep channel of 50 fathoms depth and over as far as 3° W. Between Troup Head and Rattray Head, however, there is a succession of "deeps" (the Kinnaird Deeps) some of which exceed 100 fathoms. With the exception of the

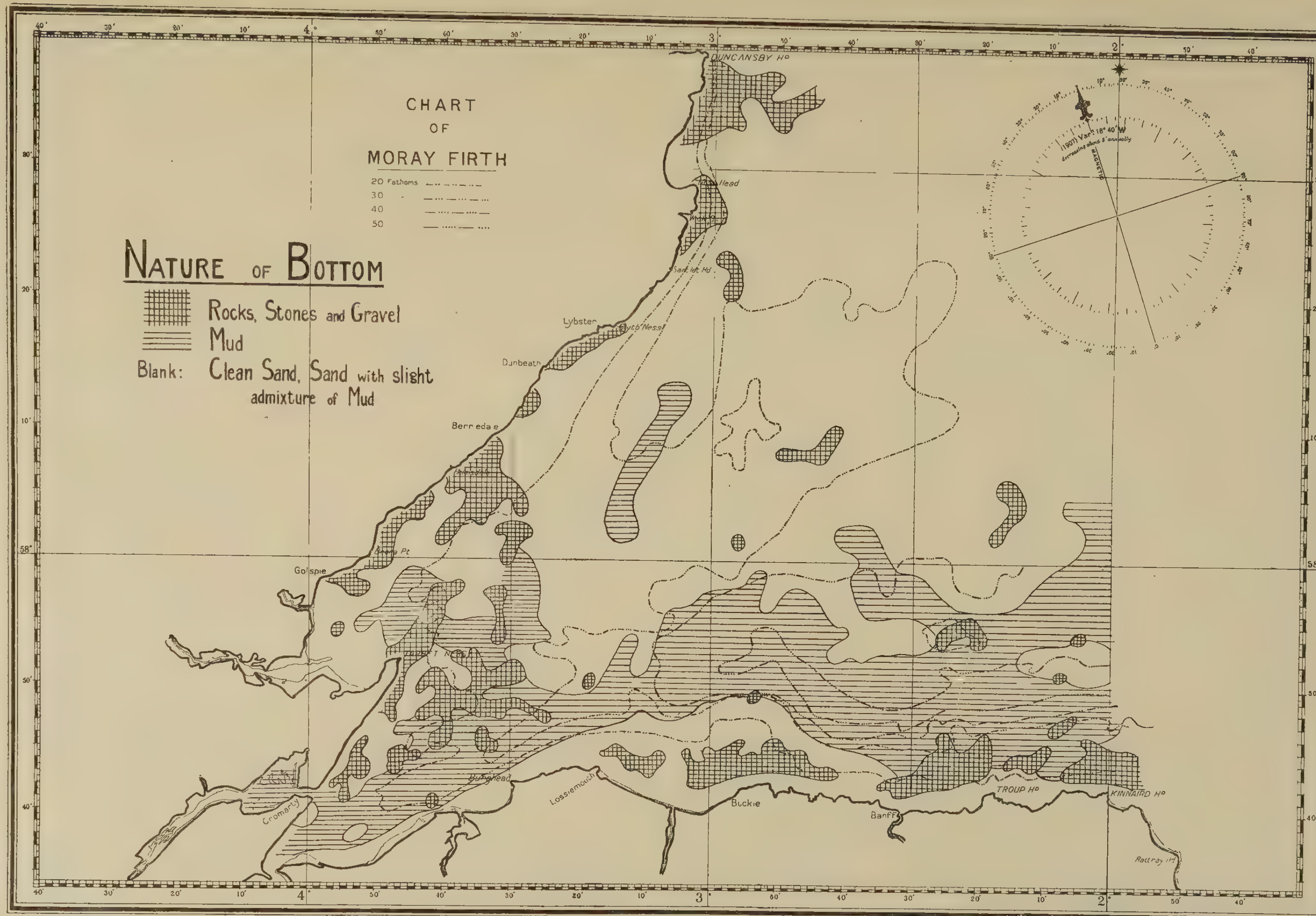


CHART
OF
MORAY FIRTH
20 Fathoms
30
40
50
NATURE OF BOTTOM
Rocks, Stones and Gravel
Mud
Blank: Clean Sand, Sand with slight admixture of Mud
DUNCANSBY Hᴰ
Lybster
Dunbeath
Berriedale
Golspie
Cromarty
Lossiemouth
Buckie
Banff
TROUP Hᴰ
KINNAIRD Hᴰ
MAGNETIC
(1907) Varⁿ 18° 40' W

Devil's Hole, a small isolated pit some 90 miles S.E. of Aberdeen, this is the only locality on the North Sea Plateau where depths of over 100 fathoms are to be found. This valley appears to be a continuation of the chain of "deeps" of the Caledonian Canal. Compare, for example, Loch Ness in which the greatest depth is 126 fathoms and the surface of the loch is only 52 feet above sea level. The deep core of this gully is filled with a blueish grey mud which gradually becomes coarser in texture in the shallower depths according to the degree of admixture with sandy particles. On the southern edge of the valley the various contours of depth run closely parallel and the descent from the edge of the shallow coastal zone to the gully is rapid. On the northern side of the valley the gradient is not so abrupt, the ground gradually rising to merge with the shallower Smith Bank promontory. On this slope there is a shallow bank of less than 30 fathoms which is much frequented by the fishermen from the adjacent ports on the south shore.

The action of the tides affects considerably the character of the bottom on the southern slope of the gully, especially in the neighbourhood of Troup Head and Rattray Head; the finer mud is washed away and large pieces of flint and chalk are often exposed.

The shallow trough-shaped valley separating Smith Bank from the coast does not exceed a depth of 40 fathoms at its deepest part. The bottom is composed of sand with a considerable admixture of mud.

Paper No. 3.

The Bottom Fauna of the Moray Firth.

Investigations with the Petersen Bottom Sampler

by

A. C. Stephen, B. Sc.

A description of the bathymetric contours and of the nature of the bottom within the Moray Firth has already been given. The variations in depth, texture of bottom, and hydrographical conditions provide a key for the interpretation of the different types of bottom-dwelling animals which form an essential part of the food of many of the marketable species of fishes frequenting the Firth. The commonly occurring bottom-dwelling species are not scattered at random throughout the Firth, but conform more or less closely in their distribution to the major variations in the physical conditions, thus giving definitely recognisable types of fauna within different parts of the Firth.

In the present resumé of the observations made by means of the Petersen Bottom Sampler during the years 1922—25 (incl.) it is not proposed to describe in detail the distribution of all the various species which occur and for conciseness of description more or less broad distinctions have been drawn with respect to their relative densities between the forms characteristic of the sandy and muddy grounds in the shallow water of under 20 fathoms and in the waters of greater depth.

The relative densities of the various groups of these bottom forms are set out in the following table:—

Bottom Dwelling Animals. Average Number per square metre.

	Sand		Mud	
	Under 20 fms.	Over 20 fms.	20—45 fms.	Kinnaird Deep
Echinoderms	10.5	14.6	35.6	109.7
Molluscs	33.4	25.6	52.1	25.0
Polychaets	10.2	22.0	47.1	61.8
Crustacea	8.5	16.5	16.4	15.5
Other Forms	0.6	8.0	7.1	9.7

Sand under 20 fathoms.

On the sandy coastal stretches under 20 fathoms there is a very marked uniformity in the density of population.

The characteristic Echinoderms of this sandy coastal zone are *Echinocardium cordatum*, *Ophiura ciliaris* and *O. albida*, but where there is a slight admixture of mud, e. g. near Troup Head, *Amphiura chiajii*, *Amphiura filiformis* and *Echinocyamus pusillus* also appear.

Amongst the Molluscs *Tellina fabula* and *Gari ferroensis* are most generally distributed and of these *Tellina fabula* is by far the more common. On the other hand such species as *Syndosmya prismatica*, *Donax vittatus*, *Natica alderi*, and *Venus gallina* are sporadic but numerous at certain loci.

Of the Polychaets only two species of Nephthys (*N. caeca* and *N. Hombergii*, the latter being the more common) appear to be generally distributed in the sand of under 20 fathoms. *Sigalion mathildae* is taken on the very fine sandy grounds in which *Donax vittatus* is found, while *Sthenelais limicola* and *Ophelia limacina* occur where there is a slight admixture of mud.

Sand over 20 fathoms.

On the offshore sandy areas of over 20 fathoms there is always a denser population in those localities adjoining muddy areas. The Echinoderms characteristic of the shallower grounds are much less frequent and their place is taken by *Echinocyamus pusillus* and *Ophiura affinis*.

So too *Tellina fabula*, so numerous and widely spread in the shallower zone, is replaced by the allied form *Tellina pusilla*. *Syndosmya prismatica* and *Dosinia lupina* are both wide-spread, but the characteristic shallow water form *Venus gallina* is absent. *Cultellus pellucidus* and *Dentalium entalis* are common but they also spread into the more muddy areas.

Of the Polychaets, *Sthenelais limicola*, *Ophelia limacina* and *Goniada maculata* appear more frequently than they do in the inshore area.

Amphipods are also commonly taken but the Cumacea are few or absent from this part of the Firth.

Mud under 20 fathoms.

If the estuaries of the Inverness and Cromarty Firths be excluded, the areas under 20 fathoms in depth where the bottom is composed of mud are of small extent and are practically limited to the western region of the Firth. They are chiefly remarkable for the very large numbers of *Turritella communis* which appear in the sampler collections from these grounds.

Mud over 20 fathoms.

A. In the muddy areas from 20 to 45 fathoms in depth there is considerable uniformity with regard to the number of species occurring per square metre. The *Amphiura* are still the dominant Echinoderms but *Cucumaria pentactes* is generally distributed although never in large numbers. *Syndosmya prismatica* is the most common Mollusc and *Bullinella cylindracea* is more frequent on this type of bottom than elsewhere in the Firth. The Polychaet worms form a considerable part of the fauna and of these *Nephthys sp.*, *Stylarioides glauca*, *Pectinaria auricoma*, *Goniada maculata*, *Glycera syphonostoma*, *Terebellids* and *Maldannids* may be considered as the most representative forms. Amphipods are frequently found and Cumacea appear in small numbers.

B. Kinnaird Deep. The mud area of over 45 fathoms may be considered as coincident with the southern gully. This area, as one would expect, is one in which the bottom forms are uniformly distributed. As may be seen from the table, it is by far the richest area with regard to average density. The dominant group is that of the Echinoderms, the number of these per square metre exceeding that of all other forms put together. The characteristic form is *Amphiura chiajii*. This form is largely replaced by the closely allied form *Amphiura filiformis* in localities where the texture of the soil is of a less plastic nature. The average densities of the *Amphiuras*, however, remain high. The distribution of *Brissopsis lyrifera* in the Moray Firth appears to be restricted to the deeper parts of the gully.

None of the Molluscs can be regarded as specially characteristic of this area, but *Syndosmya nitida*, *Nucula nucleus*, *Turritella communis* are the most common, while *Syndosmya prismatica*, *Cultellus pellucidus*, *Cardium echinatum* and *Thyasira flexuosus* are also well represented. The comparatively small number of species and low frequency of occurrence of Polychaets are somewhat surprising since one would have expected such a muddy area to be thickly populated by these forms. *Stylarioides glauca* is the only species which may be considered as numerous although *Pectinaria auricoma*, *Nephthys sp.*, *Goniada maculata*, *Glycera siphonostoma*, *Terebellids* and *Maldannids* are also present. Although Crustacea are represented, both *Amphipods* and *Cumacea* are few in numbers.

The occurrence of *Calocaris McAndreae* here is of special interest not only because it is the only locality on the East Coast of Scotland from which the species was secured but because of its importance in the economy of the area.

Another form which is secured in this deep muddy area is *Pennatula phosphorea*, the specimens of which are usually robust and well grown suggesting favourable conditions for growth. This is in marked contrast to those taken from the deep central area of the North Sea which are usually small and stunted.

Estuarine Area.

In the Inverness and Cromarty Firths where the salinity is low the fauna is not very varied and only a few species are numerous. *Volsella modiolus* and *Mytilus edulis* are common in both Firths. Amongst the smaller species found in these areas *Syndosmya alba*, *Nucula nucleus* and *Thyasira flexuosus* are most numerous, although their relative frequencies are not the same in both Firths. *Syndosmya alba* is the dominant species in the Inverness Firth, while *Nucula nucleus* is dominant in the Cromarty Firth.

Fauna of the Rough Grounds.

On the rocky and stony grounds the encrusting Polyzoa, Hydrozoa, *Chiton sp.*, *Anomia ephippium* etc. are very common, while the following species of Echinoderms were also secured, *Echinus miliaris*, *E. esculentus*, *Asterias rubens*, *A. mulleri*, *Solaster papposus*, *Ophiothrix fragilis* and *Ophiopholis aculeata.*

The representative Crustacea are *Galathea* and *Porcellana.*

Conclusion.

An analysis of some stomach contents of various bottom feeding fishes indicated that such commonly occurring bottom forms as are already dealt with play an important role in the food supply of species occurring within the area.

For example in August 1923 and again in July 1924 in the deep water off Kinnaird Head haddocks were feeding almost exclusively on *Calocaris McAndreae*, a species which, although numerous, is restricted to the deep water of the gully. Again a series of samples of stomachs of haddocks caught at various times on the sandy ground of over 20 fathoms showed that while *Ammodytes* and *Eupagurus* (forms not readily taken in the Petersen Bottom Sampler) made up part of the food, the species which formed the bulk of the food were those which figure most largely in the Bottom Sampler hauls.

Some fifty different species of Amphipods have been taken by the Petersen Bottom Sampler in the waters of the Moray Firth, on sand and mud, and at depths of from 10 metres upwards. The same species have been found in the stomachs of Moray Firth haddocks, and in both cases the genus *Ampelisca* is the most abundantly represented.

The results of the survey with the Bottom Sampler show that the Moray Firth is not to be considered, biologically at least, as being in the same category as such other Scottish Firths as the Inverness Firth, Firth of Forth, etc.

The fauna of much of the Moray Firth is simply a continuation of that of the open sea and it is only in the Inverness Firth and Cromarty Firth and extreme western part of the Moray Firth that certain forms appear, e. g. *Syndosmya alba* which are usually associated with true Firths.

Like other shallow areas along the East Coast of Scotland, the Moray Firth is a rich feeding ground for many species of bottom feeding fishes, but the average density per square metre of the invertebrate fauna is not high in comparison with that of other East Coast areas. In point of numbers the shallow coastal area of under 20 fathoms which stretches along the southern coast line of the Moray Firth is probably as sparsely populated as any part of the East Scottish Coast down to Fife Ness, with the exception of the Kinnaird Head to Aberdeen area. There are no rich patches of ground such as the *Nucula* area in, and around, Lunan Bay or the *Nucula—Syndosmya* area of St. Andrews Bay.

Paper No. 4.

Hydrographical Survey of the Moray Firth

by

John B. Tait, B. Sc.

Introduction.

In order to arrive at a true estimate of the hydrographic conditions prevailing throughout the year and from one year to another, in the Moray Firth area, it is obviously necessary in the first place to obtain, in at least general terms, a knowledge of the cycle of hydrographic events normally taking place in the North Sea and particularly in that region of it just outside the Firth itself.

The result of systematic hydrographic investigations has been to show that Atlantic Ocean water, which is characterised by a comparatively high salinity value of about 35.30 $^{0}/_{00}$ and a relatively high temperature, is continuously flowing in large volumes over the Wyville-Thompson Ridge into the Norwegian Sea. Offshoots from this Atlantic Stream enter the North Sea by way of the channels south of the Shetlands and also round the north of these islands.

The distribution of Atlantic water in the North Sea has been found to be subject to more or less regular seasonal variation. In normal years the inflow into the North Sea from the Atlantic Ocean becomes very powerful in late spring and early summer, reaching a maximum force between the months of April and May. Thereafter a gradual decl ne in intensity of this high salinity water is observed to take place throughout summer and autumn months, reaching a minimum towards the close of the year, generally in the month of November. Abnormal conditions occur at intervals. For instance, during the winter of 1905 a second extensive flooding of the northern North Sea by salt Atlantic water took place and again, throughout the entire year 1908, the influx of Atlantic water into the North Sea was particularly scanty.

Another feature of considerable importance has been observed, namely, a normal seasonal movement of less saline coastal waters which, during summer and autumn, spread out as a surface layer over the North Sea reaching considerable distances from land. On the approach of winter these surface waters recede towards the coasts of Scotland on the one hand and Continental shores on the

other. Evidence from investigations proves that in the layers beneath the surface, inshore and offshore movements take place, complementary to this outward-spreading and recession of the surface waters.

It has also been found that during summer and autumn a large portion of the North Sea basin is normally flooded in the deeper layers by cold water of a salinity which shows it to be of Atlantic origin, but of an earlier date than the influx of the spring immediately previous. It would appear that this more or less stationary water on entering the North Sea in its state of high salinity becomes so cooled by contact with the waters of the latter that its great density causes it to sink to the deepest regions of the North Sea basin where it remains, subject only to slow mixing by convection with the less saline water above it and then probably only in its surface layers. On this assumption the deeper layers of the North Sea basin will be replenished by new water only when such water, by virtue of a greater density, seeks the lowest levels and forces the old water upwards into the region of convection mixing.

With regard to the Moray Firth it appears that Atlantic water does not penetrate very far, if at all, into this region under normal circumstances. A line drawn between Duncansby Head and Kinnaird Head marks approximately the normal western boundary of high salinity Atlantic water. Only in abnormal years, such as in the autumn of 1905 does water of 35 $^{0}/_{00}$ salinity push so far westwards as Station Sc. 30 (58°00′ N. 2°54′ W.).

Temperature.

A representation of the mean conditions of temperature prevailing throughout the year in the Moray Firth has been obtained from records extending over twenty years. These records of temperature and salinity are for the most part to be found in the "Bulletin Trimestriel". Quarterly isothermal charts have been drawn (Figs. 1—3) showing the mean characteristic temperature distribution for each of the four quarters of the year, at the surface, 20 metres' and 50 metres' depths. For their compilation, values were obtained in several cases by means of graphical interpolation having due regard to the physical disposition of the waters surrounding the point or small area in question. It must be borne in mind that these charts are comprehensive in character, but they indicate broadly the seasonal variations in temperature and the differences between coastal and offshore temperatures, in the surface layers particularly, which differences give rise to a seasonal ebb and flow of coastal waters, due to density variations.

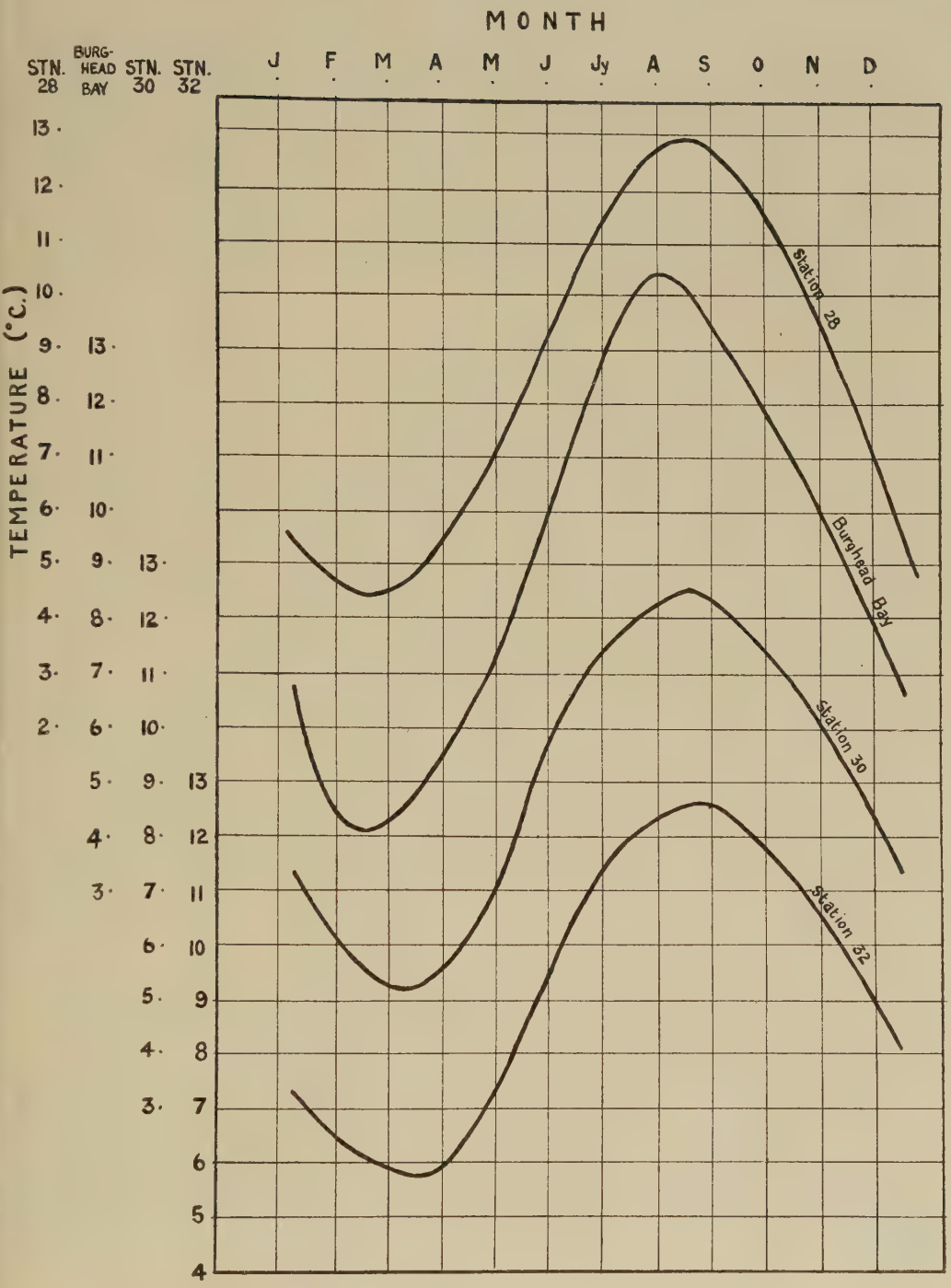
From January to March the surface temperature in the open Firth is higher than in the fresher and shallower coastal waters and there is, apparently, a movement shorewards of warmer offshore surface water, due to the fact that by contact and close proximity to land, the coastal waters at this season of the year become

rapidly cooled and consequently increase in density. As a result these waters tend to become more dense than the surface waters immediately offshore and sink below their level, thus inducing a drift of surface water towards the coast and a concomitant drift offshore of the under water layers. This movement is still apparent during the second quarter of the year, but is checked before reaching the land by the beginnings of an opposing movement from the shore waters which have become influenced by the spring and early summer warming of the land and, as a result, are expanding and beginning to move off from the shore. The extent of this movement is more rapid from the south shore of the Moray Firth than from the coasts of Caithness and Sutherland, owing, most likely, to the efflux from Cromarty Firth and Inverness Firth of fresher and warmer water. The mean conditions in respect of surface temperature from July to September are, broadly speaking, the reverse of those pertaining to the first quarter of the year. The highest temperatures occur near to the coast, especially in Cromarty Firth and along the southern shore of the Moray Firth where temperatures of 13° C. and over are recorded at the surface. In the last quarter, while the open Firth surface waters cool down gradually, the water in proximity to the land soon loses its summer heat and the extended layer of surface water once more recedes landwards.

The isotherms for depths of 20 metres and 50 metres as represented in Figures 2 and 3 show that, during the first quarter of the year, the temperature in mid-Firth rises only very gradually from the surface downwards. The rise, although very small, is sufficient to indicate that over this period of the year the surface layers even in the open Firth are slightly cooler than those underneath. Nearer the coast line, however, differences in temperature between surface and 20 metre layers are appreciable (0.5°—0.75° C.). From the second quarter charts it is apparent that the surface layers are warmer than those at 20 metres which, in their turn, register temperatures about 0.25° C. higher than at 50 metres' depth. The third quarter charts indicate very clearly a movement in the waters beneath the surface, complementary to the outward spreading of the rapidly heated surface coastal waters. Those deeper waters are, at 20 metres, almost 0.75° C. cooler than at the surface and 0.5°—1.0° C. warmer than at 50 metres. The temperatures during the last quarter of the year are nearly constant from the surface to a depth of 50 metres at least, in the open Firth, but in the Dornoch and Cromarty estuaries the surface water is distinctly cooler than that at 20 metres' depth.

In Figure 4, curves are drawn showing the mean monthly variation in surface temperature at typical points in the Moray Firth. It is at once apparent that inshore waters have a greater annual range of temperature than the surface waters of the open Firth. For instance, Burghead Bay surface waters have an annual temperature range of nearly 10.5° C., those about Station Sc. 28 (57°33′ N. 3°48′W.), a little farther offshore, 8.5° C. and as we go still further out the ranges fall accordingly, that at Station Sc. 30 (58°00′ N. 2°54′ W.) being about 7.5° C. and at Station

Figure 4.


MONTH
J F M A M J Jy A S O N D
STN. 28
BURG-HEAD BAY
STN. 30
STN. 32
TEMPERATURE (°C.)
Station 28
Burghead Bay
Station 30
Station 32

Sc. 32 (58°08′ N. 2°00′ W.) just under 7.0° C. Moreover, the curves show that the times of maxima and minima vary according to distance from the land, those waters around the coast reaching their highest and lowest temperatures in advance of the waters of the open Firth. Normally, the minimum temperature for inshore surface waters occurs about the middle of February and is approximately 4° C., while a minimum of about 5.8° C. is not reached at Station Sc. 32 until the latter half of March. Similarly, with regard to maximum surface temperatures the last week of July or first week of August appears to be the time when high temperatures of nearly 14.5° C. are attained in inshore areas, while at Station Sc. 32 the normal maximum temperature of about 12.7° C. is reached only towards the end of August.

Salinity.

Isohalines, entered upon the same charts as the isotherms, represent the mean quarterly conditions prevailing in the Moray Firth with regard to salinity. A glance at the general disposition of the isohalines in Figs. 1—3 is sufficient to indicate that seasonal variations in salinity are much less marked than in the case of temperature. In fact the annual range of salinities at any one station is small and only in the shallow waters round the coast and near the estuaries of rivers does there appear to be any decided fluctuation. This fluctuation, irregular as it may seem to be at present, will no doubt resolve itself broadly into a seasonal change when studied in detail over a long period of years.

The mean annual range in salinity of the surface waters of the Firth is from about 33.5 $^0/_{00}$ to 34.95 $^0/_{00}$. As already stated, the greatest seasonal variation occurs in the estuaries and in shore waters. Much lower salinities than 33.50 $^0/_{00}$ are sometimes met with in Cromarty and Dornoch Firths depending upon the volume of fresh water carried down by the rivers. From a mean value of 33.75 $^0/_{00}$—34.00 $^0/_{00}$ during the first quarter of the year the surface waters in this region and also the shallow waters of Burghead and Spey Bays show a distinct diminution in salinity in the second and third quarters consequent upon the inflow of warmer and fresher water from the land. When autumn is reached, these waters, which, during summer, extend over the surface of the sea thus inducing an undercurrent of salter water towards the shore, have had time to mix by convection with the salter under-water and, as a result, the mean salinity in this region during the last quarter of the year rises again to approximately 34.00 $^0/_{00}$.

About mid-Firth the change in salinity of surface waters does not become really noticeable until the third quarter of the year when the position of the 34.75 $^0/_{00}$ isohaline is considerably nearer the land than during the first six months of the year. In view of the outward spreading movement of surface shore waters during spring and summer this fact is explicable only from the point of view of convection currents.

In the outer Firth the salinity remains very nearly constant until the third quarter when an increase of approximately 0.1 ‰ salinity is observed in the surface layers. This increase continues into the last quarter of the year, reaching an average value of almost 35.00 ‰. Although, as represented on the charts, 34.95 ‰ is the highest mean salinity value for the surface waters of the open Firth in the neighbourhood of its eastern boundary, salinities of 35.00 ‰—35.25 ‰ do occur more or less frequently in this region during summer and sometimes early autumn months.

In the estuaries and in mid-Firth the salinity at 20 metres' depth is greater, more or less, than at the surface during the entire year, the difference being greater nearer the land. The waters of the outer Firth appear to be normally homogeneous with regard to salinity to a depth of 20 metres at least, throughout the year.

The isohalines at a depth of 50 metres, represented in Fig. 3, show at once that the water at this depth is, over all the Firth, more salt than that at 20 metres and again the greatest differences in salinity take place between the second and third quarters and between the fourth and first quarters. In the former case it is a marked increase in salinity which is observed at the various depths and in the latter an equally rapid diminution.

Mention has been made above of the presence during summer and autumn of cold dense water in the deeper regions of the northern North Sea. While the water of salinity 35.25 ‰—35.30 ‰ and temperature several degrees below that at the surface (about 7° C. generally) does not come within the limits of the Moray Firth as already defined by the line joining Duncansby Head and Kinnaird Head its presence during summer and autumn, under normal circumstances, in the neighbourhood of Station 34 (58°17′ N. 1°03′ W.) at depths below 50 metres has an undoubted effect upon the physical characteristics of the deeper waters in the outer Moray Firth. Station 34 is some 30 miles east of Station 32 on the same line of stations as Sc. 28—Sc. 32. A study of the disposition of both isotherms and isohalines in vertical section along this line at once reveals a gradual transition in temperature and salinity westwards from Station Sc. 34 and well into the Moray Firth area.

Currents.

It has been established as a result of extensive investigations in connection with the drift of the water in the northern North Sea that the greatest influence in the Moray Firth proceeds from the water entering the Firth from the north in a south to south-westerly direction. This main drift stream divides into two portions off the southern shore of the Firth along the meridian 3° W., the lesser portion deviating westwards towards the Dornoch Firth and then north and north-eastwards along the shores of Sutherland and Caithness, thus forming an eddy in this area of the Firth where the greater part of the fishing for spawning

plaice and cod is carried on during spring months. It is probable that minor eddies are formed in the estuaries of the Cromarty and Dornoch Firths. The bulk of the drift stream turns eastwards and moves along the southern shore of the Moray Firth towards Kinnaird Head. At certain times in some years, however, it has been observed that the drift along the southern shore of the Firth is not easterly but westerly from Kinnaird Head.

Conclusion.

In the light of the above survey we are fully justified in regarding the Moray Firth, not as a large estuary like the Firths of Forth and Tay, but rather as a bay of the North Sea. As such, both isotherms and isohalines are convex to the land and it is evident from the data that in passing from the North Sea proper into the Moray Firth area there is a gradual transition in the physical characteristics of the sea.

Figure 1. Moray Firth. Mean Quarterly Isotherms and Isohalines at the Surface.

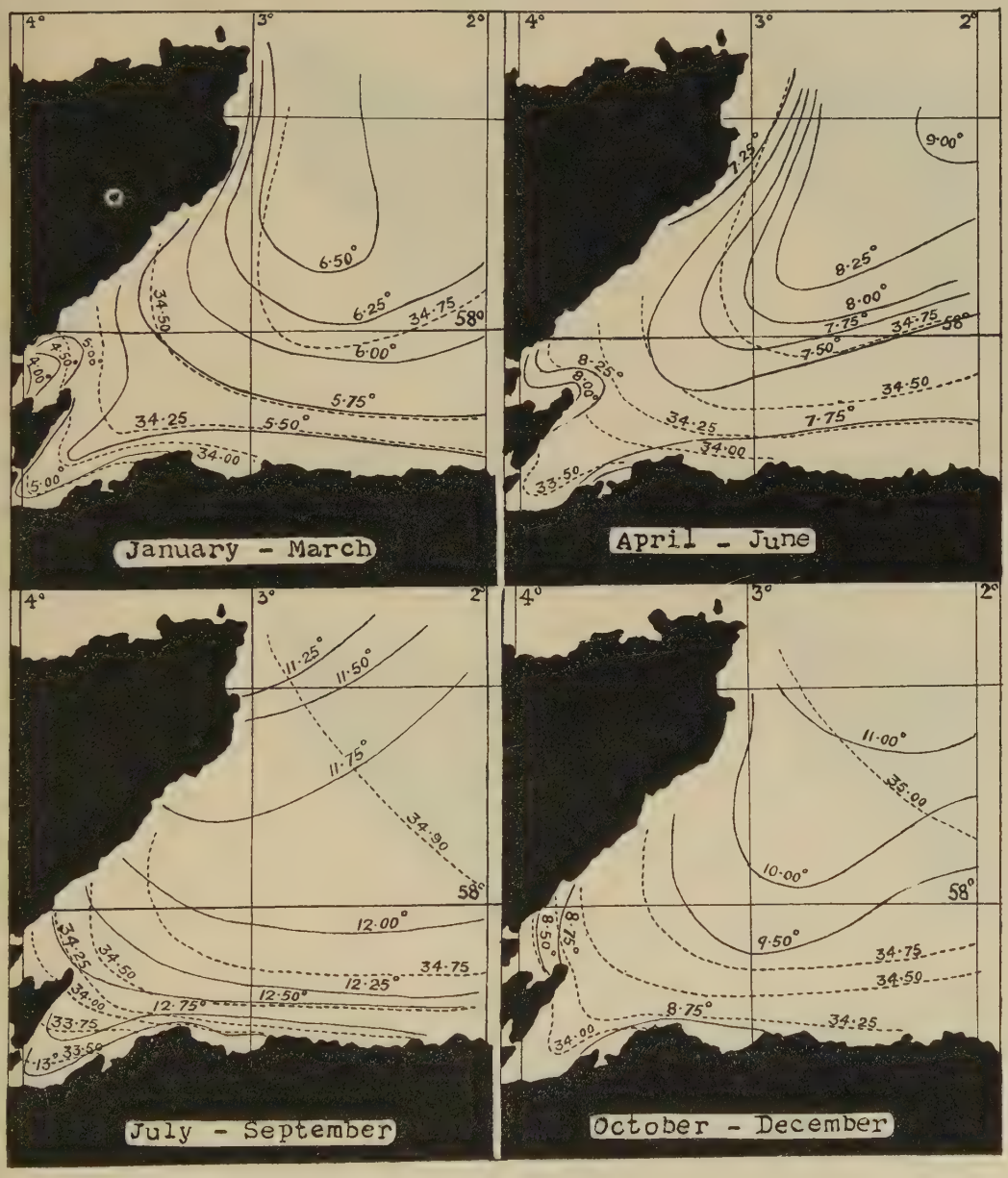


Figure 2. Moray Firth. Mean Quarterly Isotherms and Isohalines at 20 metres.

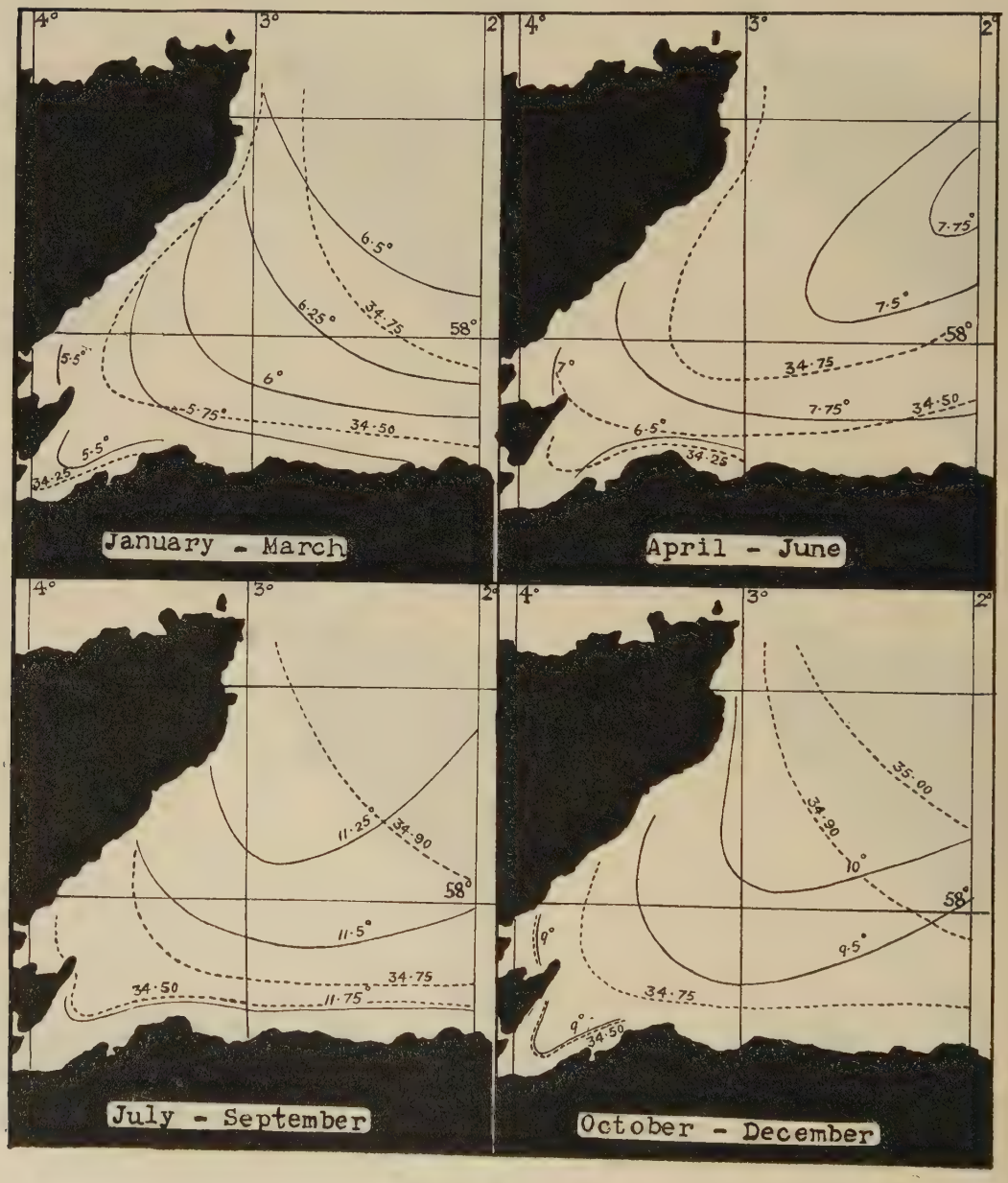
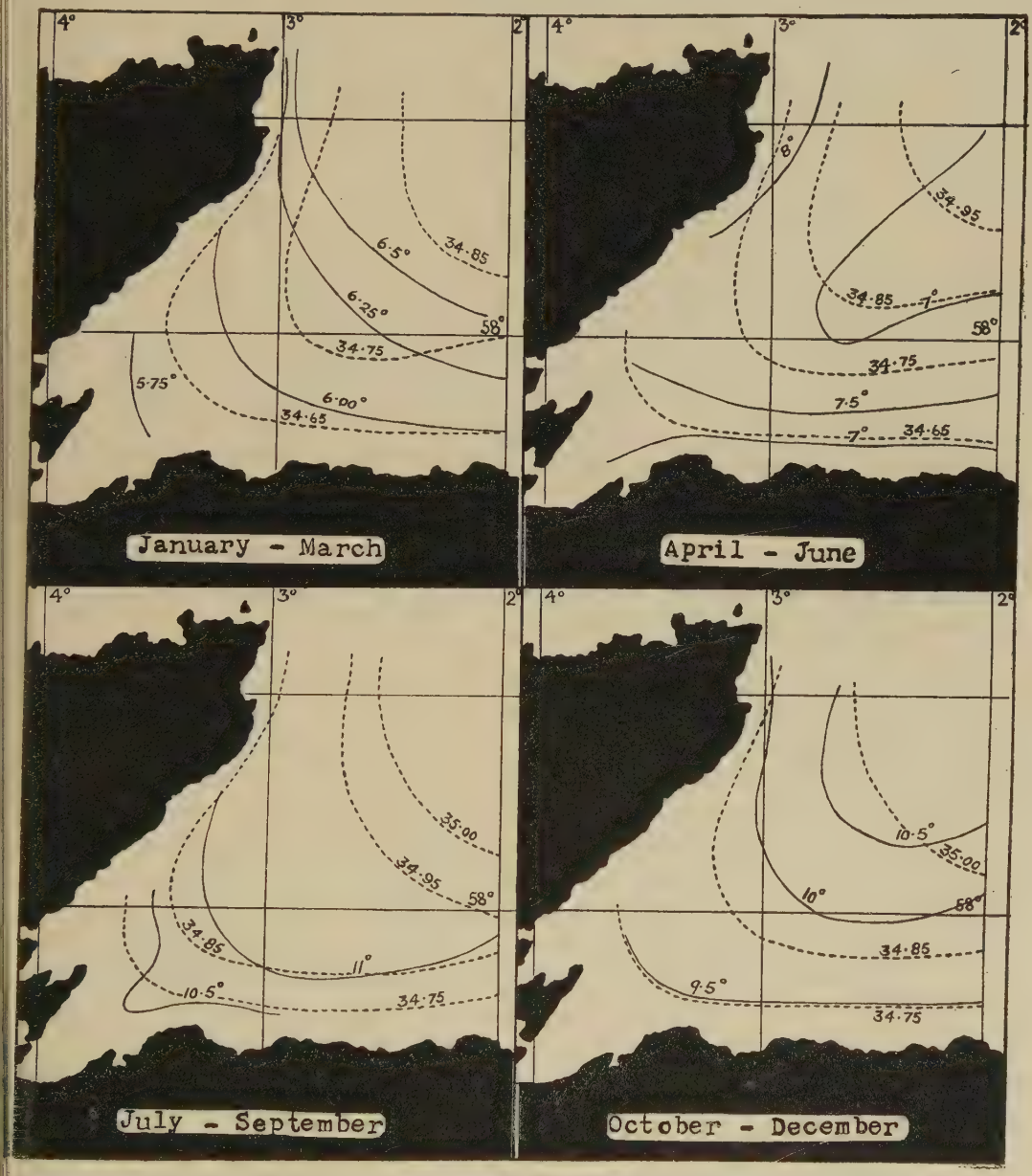


Figure 3. Moray Firth. Mean Quarterly Isotherms and Isohalines at 50 metres.



Fish of the Moray Firth

by

A. Bowman, D. Sc.

The same species are caught in the Moray Firth as in adjacent waters: there are no barriers to their emigration or immigration. The demersal species of greatest economic importance are the haddock, cod, plaice and lemon sole and these are considered in some detail in the following pages. There is no need to extend this detailed consideration to such fish as the ling, saithe, halibut and tusk as all these spawn in areas beyond the Firth and comparatively few enter it at any period in their life-history.

The species taken within the Firth show distinct preferences with regard to depth and nature of bottom though these are not the only factors controlling their distribution; the hydrographic conditions exercise a considerable influence on the seasonal distribution.

Plaice.

In the Scottish waters of the North Sea plaice are very rarely found in depths of more than fifty fathoms. Small plaice are absent from these deeper waters, but both actually and relatively to the other sizes they increase in numbers as we pass to the shallower zones.

The limits of distribution of spawning plaice are less extensive and agree very closely with the bathymetric contour line of forty fathoms. Although spawning plaice are found widely distributed in the zone within the forty fathoms, with the exception of the shallow coastal belt, spawning is most intensive in the intermediate depths. Thus the area of distribution of adult plaice is much more restricted during the spawning period. Spawning is of greatest intensity in depths of less than thirty fathoms.

In the northern North Sea the Moray Firth is the area most favoured by spawning plaice. In this area, however, the intensity of spawning falls very far short of that in the southern North Sea.

A line drawn between Noss Head and Troup Head marks approximately the outer limit of distribution of plaice spawning within the Firth but mature fish

and newly spawned eggs are comparatively few in the broad but narrowing gully penetrating the southern half of the Moray Firth and terminating off Burghead.

The analysis of the distribution of spawning loci may be carried still further. Observations have shown again and again that spawning plaice are not uniformly scattered within this comparatively restricted area of less than 40 fathoms depth. In other words the spawning is distinctly localised, there being localities of higher and lower density. The selection of localities is not fortuitous, but neither depth, salinity, nor proximity to the coast appear to be factors dominating that selection. On the other hand, temperature is apparently a factor of considerable importance with regard to the time of maximum spawning on the various localities, the latter occurring just after the temperature has reached its minimum for the year. Spawning begins and culminates earliest in the neighbourhood of the Dornoch Firth and is progressively later and later in an easterly direction. The mean minimal temperature also occurs earliest in the inner part of the Moray Firth and is progressively later and later in an easterly direction.

The plaice is the first of the species with pelagic eggs to spawn in the Firth. The vicinity of Tarbet Ness is one of the most important spawning grounds and here the process may begin before the first of January and in exceptionally early seasons it may commence even a month earlier. The time of maximal spawning in this locality occurs before the first week in February, while the mean minimal temperature also occurs early in February in that neighbourhood.

The centre of greatest egg-content is in the neighbourhood of Tarbet Ness, but its position varies throughout the spawning season and from one year to another. Spawning plaice are also found in numbers along the northwest shore of the Moray Firth where spawning is later than in the neighbourhood of Tarbet Ness; but there is considerable variation in the locality of most intensive spawning along this coast from year to year. On the south shore of the Moray Firth the final separation of the east- and west-going currents takes place in the neighbourhood between Lossiemouth and Buckie and here also high frequencies of newly spawned eggs are found. Along this shore also spawning is progressively later and less intensive in an easterly direction.

In the Moray Firth therefore the spawning period for plaice extends from December to April (both months inclusive) but in some years spawning may begin as early as the last days in November and extend into May. Mid-January to mid-March is, however, the most intensive period.

In other words, the main spawning areas of the plaice in the Moray Firth are to the west of the third degree west longitude and here most intensive spawning takes place between mid-January and mid-March.

Great mortality varying in intensity according to the conditions during the spawning season may occur amongst the eggs, larvae and post-larvae.

The dispersal of the eggs and larvae is influenced by the direction of flow

of the residual currents during the spawning season. Eggs spawned in the track of the main south-going current are rapidly drifted from the spawning grounds. In the neighbourhood of Fair Isle and east of Orkney the eggs spawned by the comparatively few mature fish there are rapidly dispersed southwards. In all probability a number of plaice eggs is carried into the Moray Firth from the area to the north of Scotland. Most of the eggs spawned in the Moray Firth to the westwards of the third meridian are kept in the eddy and drift a relatively short distance from the point of origin during the development of the embryos. On account of the prevailing hydrographic conditions in that area during the spawning period, there is, however, a tendency for those eggs which have sunk to the lower water layers to be carried offshore by the bottom current. Eggs with embryos well advanced in development may therefore appear offshore in the lower water layers before spawning has begun there.

On the south shore of the Moray Firth eastwards of Lossiemouth, the prevailing current carries the eggs and larvae in an easterly direction and a considerable number of these help later to recruit the inshore grounds on the east of Scotland, south of Rattray Head.

After a more or less prolonged incubation period the larvae hatch out and the young bottom forms are found distributed along the coastal belt and on the shallow sandy beaches in the early summer months.

The degree of dispersal of the larvae along the strand region also varies from year to year producing local variations in the number of small plaice in the sandy bays a year or two later.

During the first year the young bottom forms remain in very shallow water feeding and growing and larger numbers of these may be caught in summer in the shallows. As the fish grow they gradually draw offshore and seek the deeper waters. Round the Scottish coast, however, the 12, 15 and 20 fathom contour lines of depth approach the coast very closely and plaice seeking the offshore grounds as they grow have a relatively small distance to travel before reaching these depths. Such conditions are in marked contrast to the southern North Sea where the 12 and 15 fathom contour lines of depth are at a considerable distance offshore.

The small plaice of the Moray Firth are most numerous in the shallow sandy bays (Dornoch, Burghead, Nairn and Spey Bays) in the inner portion of the area.

The following table gives the percentages of fish in the total catch below specified sizes as ascertained from a series of trawling experiments carried out in the area during the period March 1920 to March 1921.

Plaice.

Depth. — Less than 20 fathoms. (Total Number of Fish measured given in brackets).

	Year 1920							1921	
	Mar. (1566)	Apr.—May (1538)	May—June (1457)	June—July (12981)	July—Aug. (3341)	Oct. (375)	Dec. (979)	Feb. (1254)	Mar. (3302)
% of Catch below 20 cm.	54.7 (857)	51.5 (892)	52.3 (762)	52.0 (6754)	27.0 (902)	3.4 (13)	0.2 (2)	9.7 (122)	20.0 (661)
% of Catch below 26 cm.	73.5 (1151)	77.1 (1197)	73.0 (1064)	78.3 (10173)	70.8 (2366)	35.5 (133)	16.5 (162)	28.7 (360)	54.8 (1810)
% of Catch below 30 cm.	88.7 (1390)	85.9 (1321)	80.7 (1176)	83.4 (10825)	78.4 (2619)	47.7 (179)	42.5 (416)	45.0 (565)	70.6 (2334)
% of Catch below 35 cm.	95.3 (1493)	88.5 (1362)	85.7 (1249)	87.6 (11371)	82.8 (2766)	64.0 (240)	60.0 (587)	61.7 (774)	84.3 (2783)

Depth: Over 20 fathoms.

	(243)	(488)	(124)	(87)	(261)	(118)	(192)	(899)	(577)
% of Catch below 20 cm.	Nil	9.0 (44)	1.6 (2)	Nil	Nil	Nil	Nil	0.6 (6)	2.1 (12)
% of Catch below 26 cm.	Nil	32.1 (157)	5.6 (7)	1.15 (1)	1.9 (5)	Nil	Nil	4.2 (38)	19.6 (113)
% of Catch below 30 cm.	0.7 (2)	34.3 (182)	8.8 (11)	4.6 (4)	3.4 (9)	2.5 (3)	2.0 (4)	9.4 (85)	36.4 (210)
% of Catch below 35 cm.	5.9 (16)	44.4 (217)	16.1 (20)	13.8 (12)	7.6 (20)	15.2 (18)	9.0 (17)	17.4 (157)	46.8 (270)

These tables show conclusively that in the Moray Firth area the number of small plaice less than 26 cms. caught beyond the 20 fathom contour line of depth is extremely small and that the number of small plaice less than 20 cms. beyond that depth is practically negligible. The relatively high percentage of small plaice in the April—May experiments from depths over 20 fathoms is due to the fact that the experimental trawling was carried out on the rapidly shelving ground off Burghead in the near vicinity of the 20-fathom line.

In Scottish waters of the North Sea the number of plaice caught under marketable size is extremely small. Only on certain very restricted grounds such as Aberdeen Bay and St. Andrews Bay and only in certain years are they caught in any appreciable numbers. Practically all plaice under marketable size in Scottish waters are within the territorial zone.

The following are the frequency distributions of sizes of plaice caught in Aberdeen Bay in September 1925.

Plaice.

Size in cms. ..... Haul	13	14	15	16	17	18	19	20	21	22	23	24	25
Frequency .... A.	—	—	2	8	43	82	107	130	120	85	55	53	24
— ..... B.	5	24	53	109	197	281	295	222	153	73	51	22	16

Size in cms. ..... Haul	26	27	28	29	30	31	32	33	34	35	36	37	
Frequency..... A.	24	8	4	4	1	—	—	—	1	—	1	1 =	753
— ..... B.	6	5	1	1	—	1	—	2	1	1	2	1 =	1520

Both hauls were taken with the ordinary commercial trawl (Granton pattern) and were each of one hour's duration. Haul A. was taken in water of 51 metres depth, while Haul B. was taken in the shallow water of less than 30 metres.

In Haul A. less than 6 per cent. of the catch was above 25 centimetres in length, while in Haul B. although fish over 25 cms. were probably present in greater absolute numbers, they formed less than one and a half per cent. of the total catch. Haul A. was taken beyond the territorial limit, while Haul B. was taken within the three-mile limit.

This phenomenon occurs with greater or less regularity every year when plaice of under 26 cms. in size seek offshore beyond the territorial limits off Aberdeen in the autumn and winter months. The magnitude of the phenomenon varies greatly, however, and in most years is too small to draw attention to it. In view of the fact that these plaice are caught in the near vicinity of Aberdeen and occur at a time when severe weather conditions often prevent the smaller trawlers from proceeding far from port these small vessels are induced to fish on the grounds in years of plenty. Such years occurred in 1910, 1911 and 1925.

The chief nursery for plaice on the East Coast of Scotland south of Rattray Head is St. Andrews Bay and here similar sizes to those found in Aberdeen Bay are to be caught. The percentage of plaice over 26 cms. in length varies, but is always extremely small. Small vessels using the seine net are permitted to fish within the territorial limits on the East Coast and they capture a considerable number of these small fish. A minimum size limit of 8 inches (20.3 cms.) is prescribed for plaice landed by these small vessels.

During the last few years a number of marking experiments have been made on the small plaice of these shallow sandy bays.

The following are the returns from the experiments for the separate years.

Year	Numbers marked and liberated	Recaptured to 31st December 1926 Numbers	Percentages
1923	499	313	62.7
1924	300	221	73.7
1925	248	109	43.9
1926	760	310	40.8
	1807	953	52.7

With only a few exceptions these fish were recaptured in the near neighbourhood of the places of liberation.

During the month of March and the first week in April 1920 an intensive trawling survey was made of the Moray Firth area and the maturities of all plaice caught were determined. This time of the year is singularly appropriate for carrying out such observations for at this time spawning is still proceeding and few or no mistakes need be made in judging from the macroscopic appearance of the sexual organs as to whether a particular individual of either sex is likely to spawn or has already spawned during the season. In other words the mature fish can be distinguished readily from the immature ones with precision — a diagnosis which is carried out with considerable difficulty and much uncertainty at other periods of the year. During this period all mature males are as a rule very easily determined as the spermatic fluid may be extruded by slight pressure with the fingers on the abdominal walls. Spawning females, too, are detected with facility, and spent fish of this sex are usually very lean with the flaccid ovaries extending far down towards the tail, the empty condition of the ovary being detected by slight pressure with the fingers or by holding the fish up to the light. Late spawning females have the ovaries sufficiently far developed to leave no doubt as to their classification. All observations were, however, confirmed by the dissection of the fish. The total number examined was 3,052, of which 1,854 were males and 1,198 females. The immature males caught ranged in size from 11 cm. to 41 cm., while the mature specimens ranged from 27 cm. to 52 cm. The smallest mature female was 25 cm. and the largest 75 cm., while the immature forms ranged from 13 to 46 cm. The sizes at which half of the fish were mature and half immature were 33 cm. for the males and slightly over 35 cm. for the females. It may therefore be stated with confidence, as these observations were made towards the end of the spawning season, that the mean size at first maturity for the male plaice of the Moray Firth is not less than 33 cm. and the mean size for the females is not less than 35 cm.

Search for food etc. direct the young growing plaice in their seasonal offshore and inshore movements, but on the approach of sexual maturity the instinct to breed compels the maturing fish to seek out favourable spawning grounds. Marking experiments have shown that at the approach of the spawning period (usually in the late summer or early winter months) there is a general northward movement

of maturing fish along the East Coast. Plaice in the Firth of Forth at the approach of maturity may migrate to the Moray Firth and some mature plaice from the latter area may move round to the north of Scotland and even to the West Coast.

Two groups of marking experiments carried out in the Firth of Forth — an area closed to trawling — have been selected to show that just before the spawning period the migrations of the adult fish are much more marked with regard to direction and rapidity than at other times of the year. In the experiments of Group I the fish were liberated in November—December, while in Group II the liberations were made in April—May.

The following table which includes only those migrants which had travelled more than 30 miles in a northerly direction gives the percentages of recoveries within each period of 50 days after liberation.

Marked Plaice. Firth of Forth.

Experiment	Month of Liberation	Northerly migrants for more than 30 miles. Percentages recaptured within each 50 days.													
		50	100	150	200	250	300	350	400	450	500	550	600	650	700
Group I	Nov.-Dec.	4.8	16.1	17.7	8.1	1.6	6.5	8.1	3.2	6.5	11.3	1.6	1.6	1.6	1.6
— II	Apr.-May	1.1	1.1	3.2	4.2	9.6	19.1	12.8	9.6	4.2	4.2	—	4.2	4.2	9.6

The spawning migration is not only indicated by a comparison of the varying rates of recapture in the two groups but also in both cases by the slow rate of recapture during the summer months becoming accelerated during the ensuing spawning period.

The northerly migration of the maturing adults, although the dominant one, is not without exception and indeed other marking experiments have indicated that some of the plaice from Shetland and Fair Isle may seek the Moray Firth at spawning time.

The selection of the spawning places, the influence of the prevailing currents on the planktonic stages, the gradual offshore movement of the young plaice with increasing age and size, the compensatory northerly movement of the adult plaice, all tend to show that the stock of plaice on the Scottish coast is practically a self-contained one and the life-cycle from egg to adult is passed through within the area.

Although the plaice fisheries of the northern North Sea are of minor importance when compared with those of the southern North Sea, they are relatively of considerable importance to Scotland and since the stock on the Scottish coast is practically a self-contained one the Moray Firth as the locality most favoured by spawning plaice plays an important part for the maintenance of the stock.

Haddock.

In view of the importance of the haddock to the local fisheries the natural history of the species is given at length in a separate chapter.

Cod.

In view of the fact that the life history of the haddock is dealt with in considerable detail there is little need to treat that of the cod in the same exhaustive manner. It is necessary to refer only to those aspects in its life history which appear to have a bearing on the present subject.

The cod has a wide geographical range in the northern hemisphere and on the European coasts this extends from the Bay of Biscay in the south to the Arctic Circle in the north. It is common over all the North Sea plateau from the shallow coastal zones to the deepest parts of the northern section. It is also abundant in the areas to the north-west of Scotland.

There are no barriers to its movements within this wide range on the North Sea plateau and the cod frequenting the Moray Firth at any particular moment constitute only an infinitesimally small proportion of the total stock.

Except at spawning time or when feeding on herrings etc. the fish are not found in very dense shoals. They are omnivorous feeders and grow very rapidly.

On the approach of the spawning time in spring, however, the mature individuals begin to segregate into shoals. In the north-western area of the North Sea there is a more or less normal sequence of events during this period of concentration. Shoaling appears to begin earliest on the north-west of Scotland and as the season advances shoals appear in the North Sea, the concentration occurring earliest in the north-western area and later extending further into the North Sea towards the Aberdeen Bank. These shoals are on the move and are difficult to locate from day to day. Some of these concentrations appear in the Moray Firth and shoals of considerable size penetrate to the inner reaches. These Moray Firth spawners, however, represent only a very small fraction of the total number of mature cod in the North Sea.

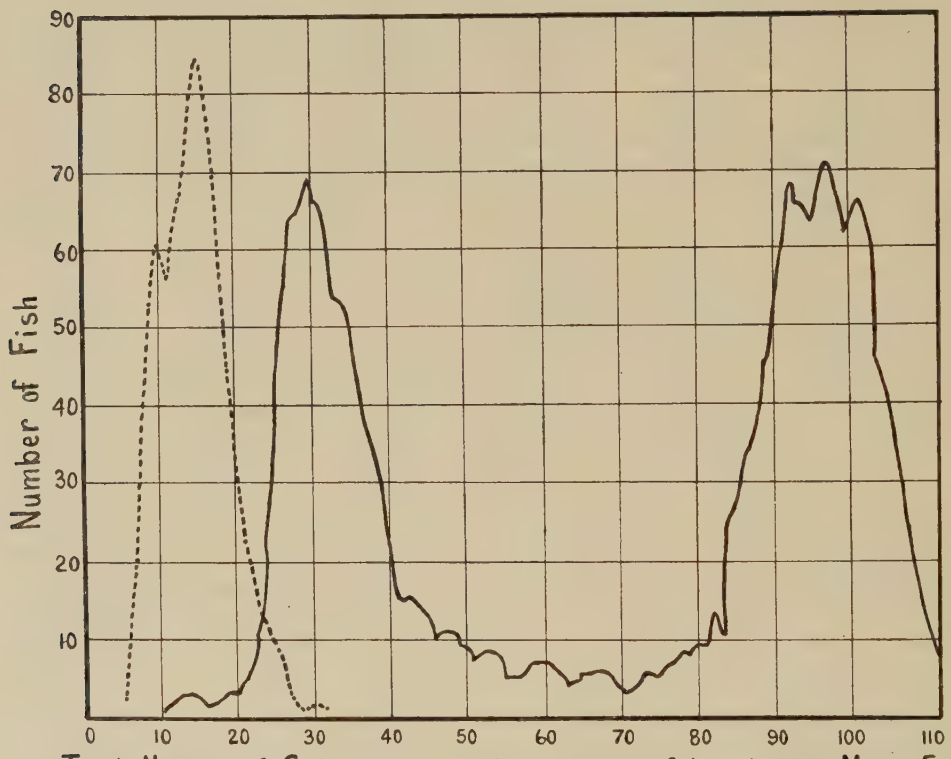
The greatest concentrations in the Firth take place to the westward of the third degree of west longitude. In some years the maximum density is in the neighbourhood of Tarbet Ness, in other years it is closer to the north-west shore, sometimes in the vicinity of Brora, sometimes at Clyth Ness etc.

The cod spawns slightly earlier than the haddock but there is considerable overlapping in the spawning periods. There is, however, a remarkable difference between the two species with regard to the ultimate dispersal of the larvae. While the small fry of the haddock tend to seek the bottom in the deeper water and are found in abundance only in the deeper waters, the cod fry very early begin

to seek the shallows and the sea-weed zone and by the end of the summer are to be found only in the shallow areas.

There they feed and grow and by the end of the year the young cod are approximately the same size as the haddock. During the second summer, however,

Figure 1.



Total Number of Cod caught, at each centimetre of length, in the Moray Firth, during the quarterly period January - March (1903 - 1909).
(D'Arcy W. Thompson: Rapp. et Proc. Verb., Vol. XIII, C 2, p. 8)

the young cod grow much faster than the haddock and in the third summer the difference is still more marked.

As the cod grow and increase in age they leave the sea-weed zone and the shallow waters and seek their food in the open sea so that by the end of the third year many of those born within the Moray Firth have left its precincts.

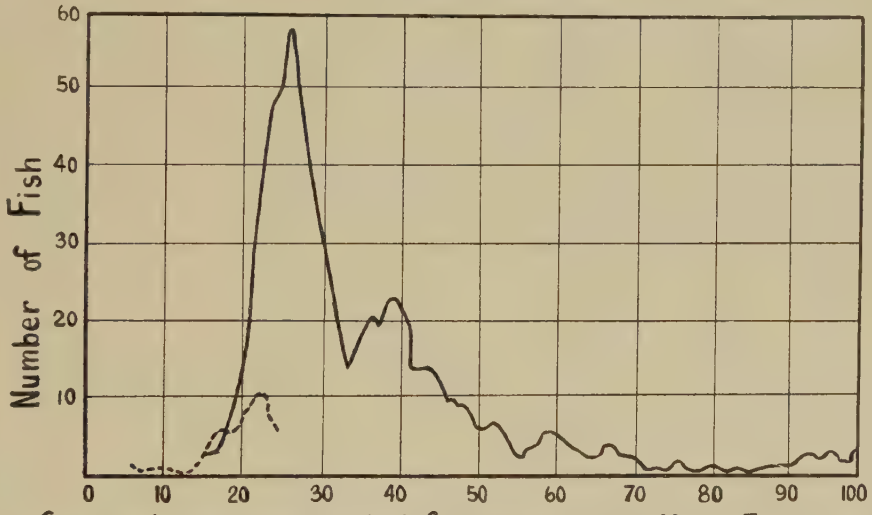
The size frequencies of cod occurring in the Moray Firth in the different quarters of the year are exemplied in the analysis given by Prof. D'Arcy W. Thompson in Rapports et Proces Verbaux, Vol. XIII, 1911, of the trawl catches made

by the Research Vessel "Goldseeker" in that area and his graphs representing the conditions in the first and third quarters are reproduced here.

In the Moray Firth area, then, the cod of one and two years old are found in greater abundance in the narrow coastal zone, while the fish of three years old are found in smaller numbers more generally distributed throughout the Firth.

Thus there is an exodus, or emigration, of fish from this region after the age of two years, and an immigration into the Moray Firth of fish of about five years old and upwards during the spawning season.

Figure 2.



Sizes (and approximate ages) of Cod captured in the Moray Firth: July - Sept.
(D'Arcy W. Thompson: Rapp. et Proc. Verb., Vol. XIII, C 2, p. 9)

At all seasons of the year the conspicuous feature is the marked scarcity of cod in the Moray Firth between the sizes of 50 and 80 centimetres although a few of these may be found generally distributed. The adult fish enter the area in numbers just before spawning, leaving the precincts of the Firth once more when spawning is over.

Lemon Sole.

Since the adoption of the Danish seine net by Scottish fishermen the Lemon Sole has become of considerable importance to the fisheries of the Moray Firth and it now bulks largely in the catches of the vessels using this more modern gear. Prior to the introduction of this apparatus most of the Lemon Soles taken in the waters of the Firth were captured by non-British trawlers, only a very small number

being caught by local fishermen principally in the Banff district by means of set flounder nets anchored a few miles from the shore. Lemon Soles do not take the baited hooks.

This species prefers a habitat of moderately deep water and a bottom of muddy sand in which worms are abundant. Except in a few very localised grounds its frequency of occurrence cannot be compared with that of the haddock, cod or plaice. It is characteristic of the Lemon Sole that on the grounds which it frequents it is rarely captured in such numbers as the plaice on the plaice grounds.

The Lemon Sole spawns in moderately deep water mainly in the summer months and the larvae after undergoing metamorphosis settle down on the bottom. In view of the characteristics of the post-larvae the pelagic period is probably comparatively long but practically nothing is known regarding the distribution of the first bottom stages. These are of extremely rare occurrence even in catches made with very fine meshed trawls. Indeed young Lemon Soles appear to be practically immune from capture by the ordinary otter trawl until they reach a size of 13 centimetres and even at these small sizes the numbers caught are almost negligible.

Marking experiments carried out during the last few years have added considerably to our knowledge of the life history of the Lemon Sole of the East Coast of Scotland and of the Moray Firth area. During the period 1919—24 (incl.) a total of 3232 individuals was marked and liberated in Scottish waters and of these 321 were recaptured before 1st January 1926.

The marking experiments have demonstrated that only about 20 per cent. of the recaptured Lemon Soles show any sign of definite migratory movements so that it would seem that it is a comparatively stationary fish. The movements of those which do migrate are, however, comparable to those of the plaice; the trend of the movement is northwards along the East Coast to the Moray Firth and from the Moray Firth round the north coast of Scotland to the west side.

It is a remarkable fact that a number of the marked Lemon Soles recaptured not far from their places of liberation had escaped capture for more than two years on grounds which are subjected to continuous trawling operations. Most of the Lemon Soles after spawning appear to have remained on the spawning grounds to recuperate, spawning for a second and even a third time in the same locality. This is a characteristic feature of many of the Lemon Soles in the Moray Firth area.

The rate of growth, especially in the early years, is slow and although some mature at the small size of 18 cms. most of the individuals do not reach maturity before five years when they have an average size of at least 23 cms.

Other Species.

The distribution of the Witch (*Pleuronectes cynoglossus*) is in marked contrast to that of the plaice. The latter, as has already been stated, frequent sandy ground of less than 40 fathoms in depth. The witch, on the other hand, rarely occurs in such shallow water but prefers the muddy ground of greater depth. The centre of distribution in the North Sea is on deeper grounds beyond the limits of the Firth but in the southern muddy gully conditions appear to be suitable and the species extends its distribution into this and may be found in considerable numbers to as far west as Burghead. It is from this restricted area that the witches caught by trawlers and Danish seine net vessels working within the Firth are mainly taken. The species is not caught by hook.

The contingents of adult hake which in their annual incursions of the northern North Sea arrive by the Scotland-Shetland passages extend their distribution into the Moray Firth along the deeper northern valley and southern gully where they are caught during the summer and autumn months by Danish seine net. The hake does not appear to spawn with any great intensity in the north-western part of the North Sea, but every year the deeper valleys of the Moray Firth are recruited by the influx of a variable but small number of "baby" hake which are probably born on the grounds to the north or north-west of Scotland, or in exceptional years in the north-western area of the North Sea. When one and two years old these hake may be caught by trawl in these deeper muddy valleys.

Other immigrants from the west appear to take a similar route. They confine themselves to the outer and deeper parts of the Firth and only very few reach the inner parts. The Angler and Conger Eel are found in largest numbers in the deeper muddy valleys. These immigrants begin to arrive about mid-summer and remain until the spring months. The numbers and time of arrival depend on the species and on whether the conditions are favourable or otherwise during the season. Their abundance or scarcity, however, provides an index to the fluctuations in the conditions in the outer parts of the Firth in the various years.

Paper No. 6.

The Haddock of the North-Western North Sea.

By

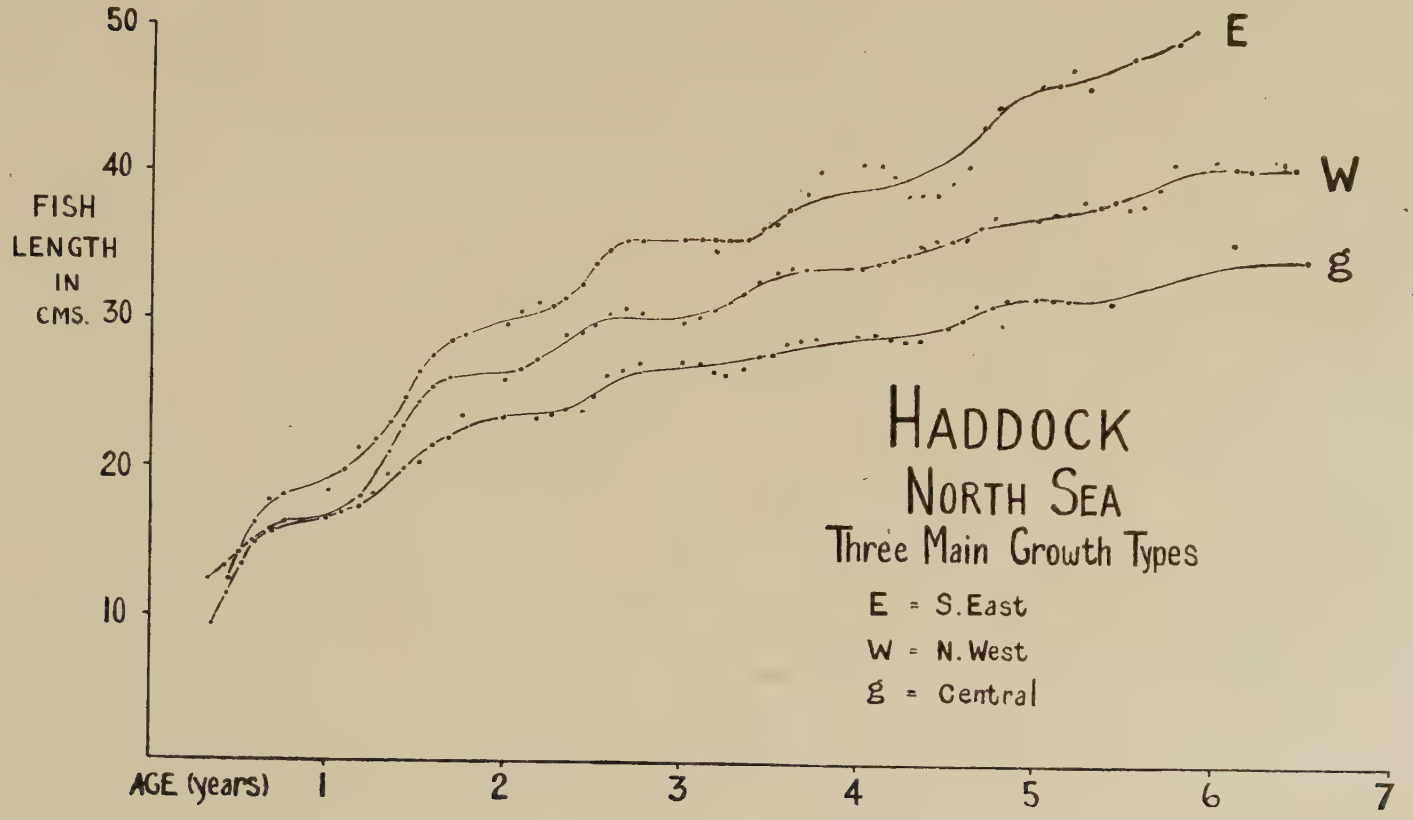
Harold Thompson, M. A., B. Sc.

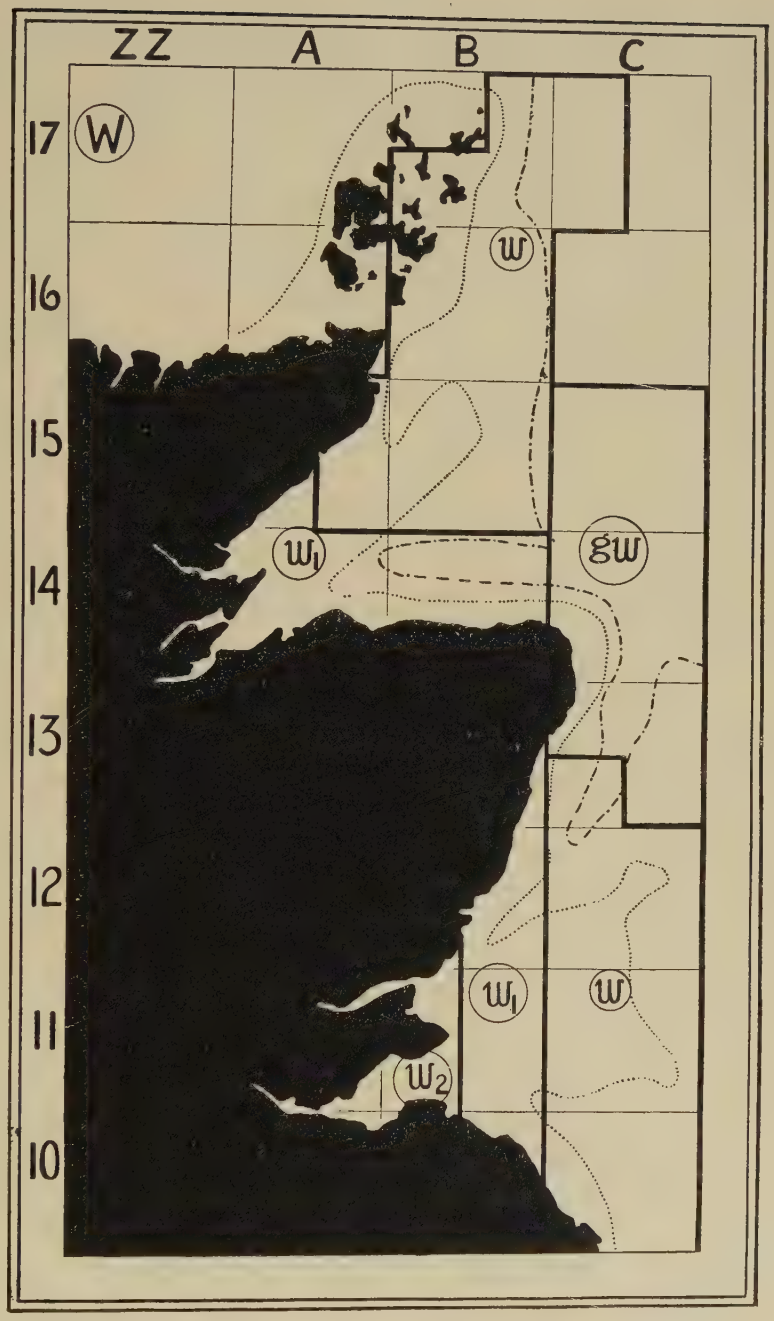
The Haddock is the most important demersal species of the north-western North Sea. It is the main object of the trawl fishery in this area and contributes more than half by weight of all the fish caught by this method of fishing. For the small line fishermen of the East Coast of Scotland carrying on operations within comparatively short distances of the coast the species is of paramount importance at all seasons of the year. In the Moray Firth area where small line fishing is still the most important of the fisheries carried on in local waters the Haddock contributes over 70 per cent. to the gross weight of the catches. Since the introduction of the Danish seine net into the Moray Firth the Haddock, although third with regard to the value, has provided the greatest weight of fish caught by this method. Thus, the species is the most important one for the local fisheries of the Moray Firth.

The home of the Haddock is in the northern and deeper parts of the North Sea and here spawning takes place from January to May but chiefly from mid-March to mid-April. The tiny larvae hatched out from the eggs live a pelagic life in the upper water layers and as they grow are distributed under the influence of the prevailing currents over a wide area before they commence their demersal life. At the end of the summer practically all the brood have assumed a bottom habitat and thereafter remain typical demersal fish.

The Position of Moray Firth Haddock in a Classification according to Growth Rate.

After first reaching the bottom the Haddock, at least for the first two years of life, does not indulge in lengthy migrations. At this period of life the species occurs in shoals and on the Scottish side there is merely a short north-easterly swaying movement in winter and a return south-westerly movement, of little longer stride, in summer, as the shallower water gains in temperature and salinity and produces a more copious food supply of invertebrates than occurs in the deeper,


50
40
30
20
10
FISH LENGTH IN CMS.
AGE (years)
1
2
3
4
5
6
7
E
W
g
HADDOCK
NORTH SEA
Three Main Growth Types
E = S.East
W = N.West
g = Central



AREAS OF DISTINCTIVE GROWTH RATE.

then to differentiate this small area by an intermediate lettering as sub-type *gw*, small letters being used to indicate slow growth in general. From the chart it will be seen that this sub-type may easily penetrate the southern Moray Firth along the deep channel in B 14. Type *W* is, similarly, capable of sub-division, although all the Haddock of the western seaboard are in later life included in it. This we know, from growth rate observations, scale characters, studies of mass distribution and from such Haddock marking experiments as have been carried out. All evidence points to the fact that fish reared on the east Scottish coasts gradually seek northwards to the Moray Firth and Orkneys. The *W* type curve is based mainly on the growth rate of Haddock in the north-western area, including the Orkneys, Shetland and Hebrides. It is characterised by having a rather smaller first year's growth than Haddock of the Moray Firth and East Scottish coast, but this deficiency is made good in the second year, and in the later years of life growth tends to be rather more rapid than on the east coast. The Haddock of the latter are therefore designated by the letter *w* as a preliminary differentiation, although as has been said they mix with and merge into the *W* type later on. Further sub-division is however necessary in order to account for minor but consistent differences on the east coast. The marks w_2, w_1 and *w* have been employed to indicate decreasing growth rate. Thus growth is fastest in the Firth of Forth neighbourhood, which is termed w_2. Next in order — w_1 — are the inner Moray Firth and the zone lying immediately outside the east Scottish bight. The slowest growing east Scottish young Haddock are found still further offshore and in the outer Moray Firth and are lettered *w*. From these remarks it appears that the Moray Firth is tenanted by young Haddock of an intermediate rate of growth and that the coastal part of the Firth is a region of slightly faster growth than the open Firth. Even within the coastal part a still finer differentiation can be made. Thus starting from Dornoch Firth and proceeding towards Kinnaird Head at the eastern end it is found that relative size, age for age, decreases slowly in an easterly direction. Thus Haddock in A 14 are slightly better grown than those in B 14, and those in the west end of B 14 than those in the east end. All these considerations are summed up in the table on page 75.

It will be noticed that recessive figures do not occur in the Table until the latter part of year 3, when presumably the average size is prevented from increasing or even lowered by the first spawning offshore movement led by the better grown Haddock. It is also noteworthy that the average size of 23 centimetres, when Haddock become marketable, is generally attained about September of the second year, 18 months after birth. The average size of 28 centimetres, when Haddock mature for the first time, is not attained till the autumn of the third year, in the winter of which the maturing Haddock were out of the Firth. From the time between which average sizes of 23 and 28 centimetres were being attained the commercial otter trawl would thus have from 15 to 18 months during which immature Haddock would be fished.

The table is completed from the study and collation of average age sizes over a long series of years, and so allows for all variations likely to occur. It might be expected that in years of scarcity the lesser population of Haddock would find it easier to obtain food and would grow more quickly. This is not ostensibly the case, for Haddock did become relatively scarce in the North Sea in 1922—23 without there being a compensating increase of growth rate. Again it may be said that baby Haddock, on account of the rather large difference in their size from that of their nearer competitors for food — the second year Haddock — should, if such were the tendency, show a faster rate of growth in years of poor brood survival than in years when brood Haddock are very numerous. On the contrary it has been found that in whatever numbers, great or small, a new Haddock brood appears, approximately the same local average size is reached after the first twelve months. And even in the second and third years such slight differences of growth rate as occur cannot be said to be caused by the presence or absence of competition by large numbers of fish of similar size. Thus although the 1922 brood was poor in numbers and the 1923 brood very rich, the latter had by the end of the third year reached the same local size as had the former when three years old. Therefore although we find that another scarce brood, that of 1921, grew faster by 7 per cent. than either of these two, the cause must be other than that of relative density of numbers. On the other hand, upon the

Western North Sea.

Comparative Growth Rates of Haddock (in centimetres).

	YEAR 1				YEAR 2				YEAR 3				YEAR 4				YEAR 5				YEAR 6				YEAR 7			
	w_2	w_1	w	W	w_2	w_1	w	W	w_2	w_1	w	W	w_2	w_1	w	W	w_2	w_1	w	W	w_2	w_1	w	W	w_2	w_1	w	W
April	..	..	..	..	..	18.1	17.6	16.9	26.4	24.7	24.2	26.3	..	..	29.1	30.1	..	..		33.7	39.5	39.2		37.2	..	..		40.3
May	..	..	..	..	18.7	18.8	18.0	17.9	26.4	24.8	24.4	27.1	..	29.9	29.3	30.6	..	34.8		34.0	..	..		37.3	..	..		40.2
June	5.5	5.3	..	..	..	19.6	19.1	..	..	25.4	24.8	..	..	30.6	28.9	31.1	..	35.1		34.4	..	..		38.0	..	..		..
July	..	..	..	9.1	..	20.1	19.9	20.9	..	..	25.8	28.7	..	30.8	29.3	31.8	..	..		35.9	..	..		37.8	..	..		..
August	..	8.4	..	11.1	..	21.3	21.4	22.6	..	27.0	26.7	28.9	..	31.7	29.6	32.5	..	..		35.2	..	..		38.1	..	..		41.3	40.3
September	13.6	12.4	12.7	13.1	23.4	22.6	22.2	24.2	..	29.2	27.3	29.6	34.9	32.3	30.2	33.1	37.5	38.0		35.2	..	..		37.6	..	..		48.8	..
October	14.7	15.1	15.5	14.8	24.3	24.3	23.1	25.3	30.8	30.1	28.0	30.3	..	33.2	..	33.4	..	..		35.5	..	..		37.8	..	..		..	..
November	..	16.9	17.1	15.2	24.3	24.4	23.3	25.9	..	30.4	28.2	30.7	..	33.6	..	33.4	..	..		36.4	..	39.5		39.0	..	..		..	..
December	..	17.7	17.5	..	24.6	24.5	23.6	..	32.0	29.6	28.7	30.4	..	..	32.5	..	..	..		37.0	..	..		40.8	..	..		..	..
Jan.-March	18.2	17.8	17.5	15.7	24.5	24.6	24.1	25.8	31.2	29.6	29.3	29.8	36.0	34.4	33.1	33.4	39.5	39.0		36.9	42.7	..		40.8	..	..		..	..

above evidence, no justification is forthcoming for severe thinning out of young immature Haddock on the grounds that the residue would thereby grow above the normal rate.

From the table it is seen that the *w* and *W* type of growth tend to merge in the years after spawning occurs. Thus on the score of growth there is considerable support for the contention that there is considerable subsequent exchange between these areas, and for their ultimate inclusion in one general type, sub-divisible only in earlier years.

Haddock Spawning and Feeding Grounds.

In the North Sea the Haddock spawns in the deepest available water, and this is found in the great basin of the northern North Sea, and in its southern narrower continuation, the Gut. Generally speaking water of over 100 metres in depth is sought out where the temperature is fairly uniform (6—8° C.) in winter and salinity high. Over a period of three spawning seasons (1923—25) it was found that the maximum catches of Haddock occurred in 55 statistical squares. The criterion selected for the inclusion of a square within the spawning region was the attainment or exceeding of an average catch of 1 cwt. of Haddock per trawling hour. One half of these squares lay respectively north and south of the 59° N. parallel of Latitude, and the area included is shown blacked out in the chart of spawning areas given on page 78.

It will be observed that the southern limit of intense spawning nearly coincides with the course of the 100 metres depth contour, and stretches east to the Skagerak. South of this only the Gut region — and that rather spasmodically — is of importance, as for example in the vicinity of the Tail End of the Dogger Bank. The inner Moray Firth is practically abandoned by mature Haddock at this time, and is consequently of infinitesimal importance as a spawning area, although a few of the summer migrants remain to spawn. In the outer Firth (B 15) however, the catch of spawners may bring this square within the authentic spawning area in years such as 1925 and 1926, when there is a dense upgrowing Moray Firth population ripening for the first time. A large population of such Haddock do not, in making their first spawning migration from the Firth, proceed beyond the outer Firth. In fact in such seasons of masses of young spawners the latter tend to lie in a belt westerly of the main spawning shoals. This belt extends from Kinnaird Deep, off the east end of the south Moray Firth, right across the outside of the Firth via the east of Smith Bank to as far north as south-east Shetland. All of these, however, lie outside the recognised limit of the Moray Firth, with the exception of a small proportion in the more westerly part of B 15. The first spawning migration is therefore not a very long one, but it appears that each successive year sees the stride lengthened further to the north and east. Thus

from a comparative study not only of age group lengths but also of the scales of spawning Haddock the following summary of probable movement is obtained:—

Young Spawners, from the Moray Firth to the C. & D. Vertical Series of Squares.
Medium Spawners, from the Moray Firth to the D. & E. Vertical Series of Squares.
Large Spawners, from the Moray Firth to points further east, and in addition to spawning areas north-west of the Orkneys and Shetlands.

East of the F. vertical series of squares the spawning shoals tend to be mainly composed of northerly migrants from the south and east North Sea. From the nature of the scales it is, however, quite possible that a few older Moray Firth Haddock reach even as far east as this.

An examination of the average weights of ovaries (roes) fetched into the Aberdeen Market from these various regions affords interesting confirmation of some of these remarks. During the spawning seasons referred to the average weights of roes per 100 hours' trawling were: —

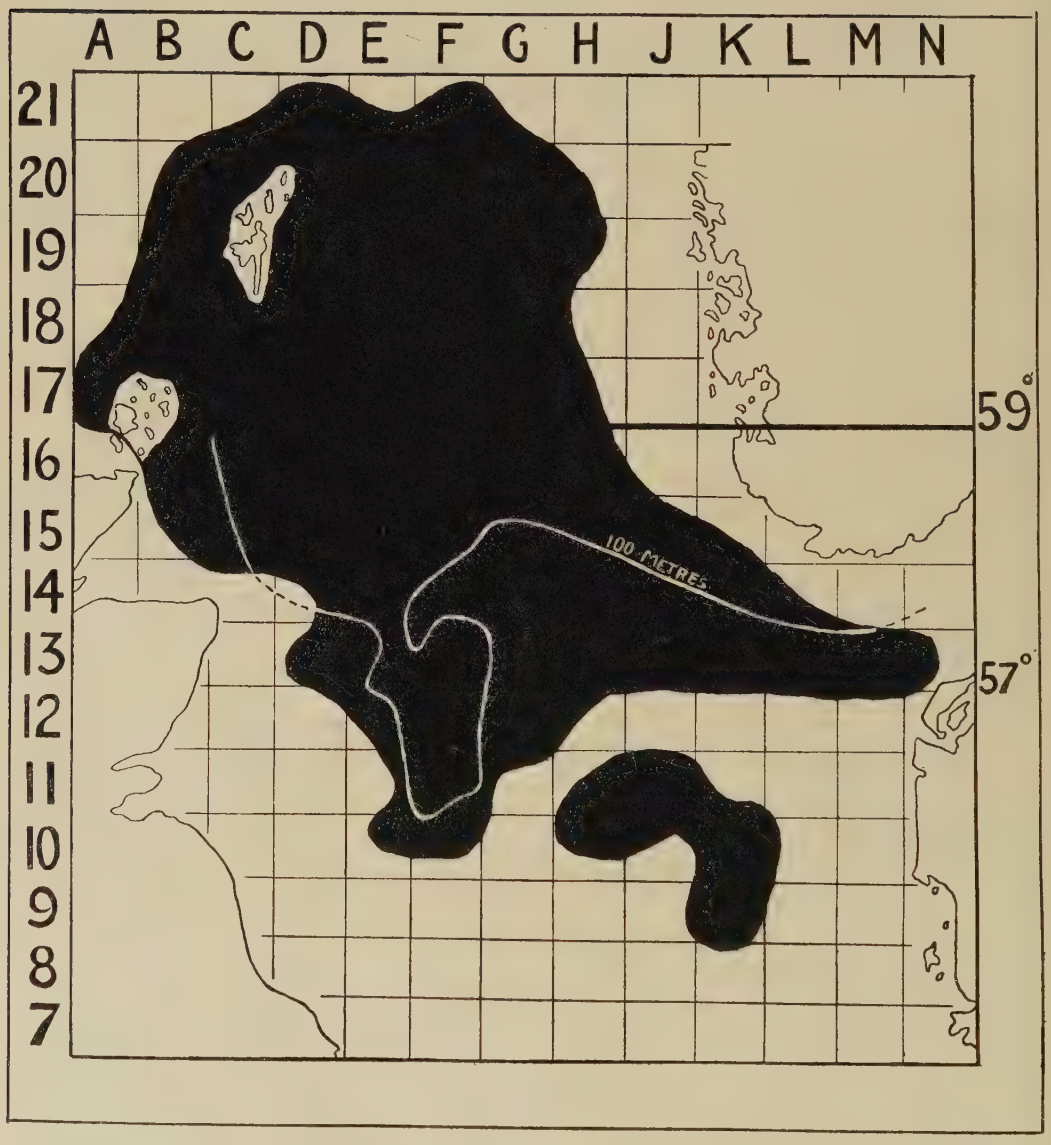
B 15 to B 17 — 3 cwt.
C 13 to C 18 — 4 cwt. A general increase
D 14 to D 19 — 5 cwt. eastwards
E 14 to E 18 — $6\frac{1}{2}$ cwt.

As the weight of the roe increases in proportion to the cube of fish length it is a fair deduction that the easterly increase is due to increased size (and age) rather than numbers of Haddock. Summing up, there is, beginning in November, an outward movement of Haddock from the Moray Firth, the general direction of which is north-easterly. This movement is, in the case of immature fish, insufficiently great to carry the young shoals beyond the outer Moray Firth. After maturity is reached, however, the movement is more pronounced, first of all to the area just outside the Firth and later in life both more easterly and northerly.

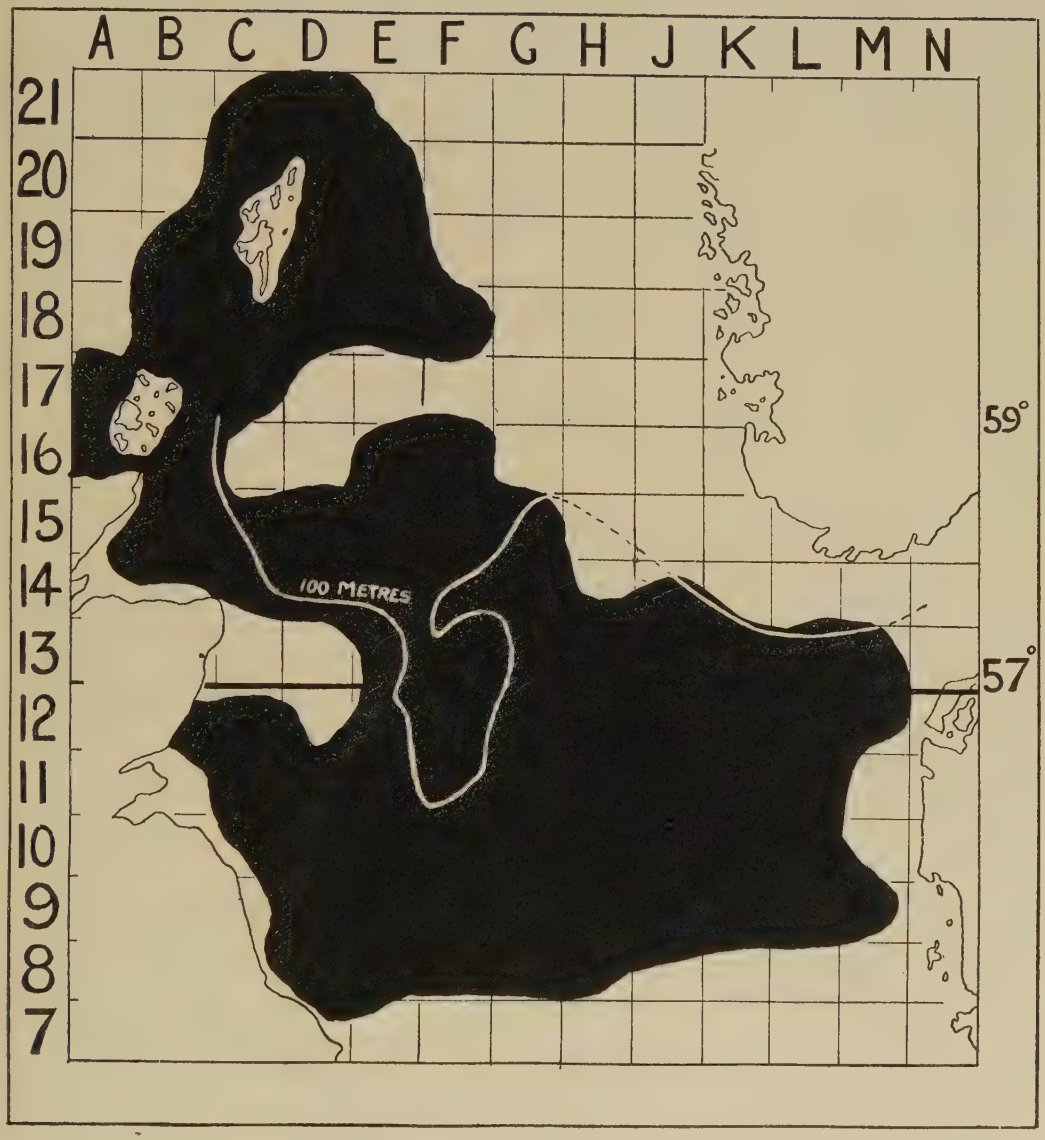
The numbers of male and female Haddock in the Firth are approximately equal, although inshore hauls yield a proportionately high proportion of females, and offshore hauls in deeper water a similarly high proportion of males. As a direct result the female fish grow rather more quickly than the male — the maximum average difference being 3 centimetres at the end of the third year. About one-half of the Moray Firth Haddock mature at the end of the second year and the remainder at the end of the third.

A glance at the chart of spawning areas shows the unique position of the Moray Firth as an open bay facing and adjoining the great spawning region of the North Sea, and therefore its continual chance of recovering, after each spawning season, a considerable number of immigrants. That some of these immigrants are from a considerable distance is perhaps indicated by the fairly regular appearance, about August, of a set of older Haddock in a semi-emaciated condition

HADDOCK SPAWNING GROUNDS
MARCH



HADDOCK FEEDING GROUNDS
SEPTEMBER



("slinks"). This is such a rare condition in which to find Haddock that one can only conclude, in the absence of disease, that these are fish which have, since spawning and losing condition some months previously, been travelling in search of suitable feeding grounds.

For the sake of comparison the second chart, showing the position of the Haddock shoals during the feeding season, is given. There are two periods of the year in which the average catch per unit of time rises to a maximum. These occur in March and September and are occasioned by the spawning and feeding concentrations respectively. For September, using the same criteria as for the spawning season, it was found that 88 squares could be regarded as important feeding areas. These had as their centre the 57° N. parallel of Latitude. This is 120 miles south of the central point in March, and hence is obtained a rough measure of the extent of the average southerly feeding migration. It is noticeable that the inner Moray Firth now becomes densely populated and that it tends to be associated with the north-western rather than the south-eastern body of feeding Haddock, although it is linked, chiefly by reason of younger fish on the southern side, with the shoals lying along the edge of the deep water in the open sea. That it has gained from a return migration from the spawning grounds lying to the north-east is indicated by the comparative blank now existing at C, D, E 16 or 17. All the indications are thus in favour of a movement of the larger type of Haddock in along the north Moray Coast and of the smaller (and for the greater part younger) fish in along the southern coast. Thus a dual relationship is established with the north-western (*W*) type on the one hand and the deep water (*g*) type on the other.

Although the feeding concentration in the Moray Firth becomes in the latter part of the year quite great it must be remembered that around the Orkneys it is much greater, and it is reasonable to regard the migrants into the Firth as the more active migrants, or the fringe of the Orkney shoals. Similarly the headquarters of the smaller Haddock are the edge of the deep central North Sea basin, and the migrants from here along the deep southern channel are similarly to be regarded merely as the advancing head of a main shoal behind.

In the section on the Hydrography of the Firth it is stated that the salinity at a depth of 50 metres increases in the third quarter of the year and diminishes in the first quarter. The movements of the incoming and outgoing larger fish from the North appear to be intimately bound up with these facts, as they are characteristically seeking out the shallower waters of the Firth. The smaller southern type is more or less independent — on account of the deeper water inhabited — of this seasonal change of salinity in the inner Firth, and hence appear earlier in the feeding season and, in the case of immature Haddock, may remain over winter. The meridian 3° W. was given as the probable line of division of the incoming, south-going high salinity current from the Atlantic into the portions, east and west-going respectively. It would also appear to be the eastern-most limit

of the advancing Haddock from the north. Thus this type of Haddock appear in the west part of B14 before they do in the east and it is probable that such as reach the south coast tend to turn westwards in a cyclonic direction. On the other hand the smaller immigrants coming in along the southern channel can penetrate past the third meridian into shallow water as far west as Burghead Bay in years when they occur in great numbers.

From a study of the numbers of fish caught it is found that:—

(1) The Orkneys lose in numbers of large Haddock between October and December, when the Moray Firth is gaining. *Vice versa* they gain in numbers in February when the Moray Firth is losing.
(2) The Orkneys lose in numbers of medium Haddock up till October, when the Moray Firth is gaining, and gain from October to July, when the Moray Firth is losing.
(3) The region east of the Moray Firth gains in numbers of small Haddock in winter and loses in summer, while the opposite course of events takes place in the Moray Firth.

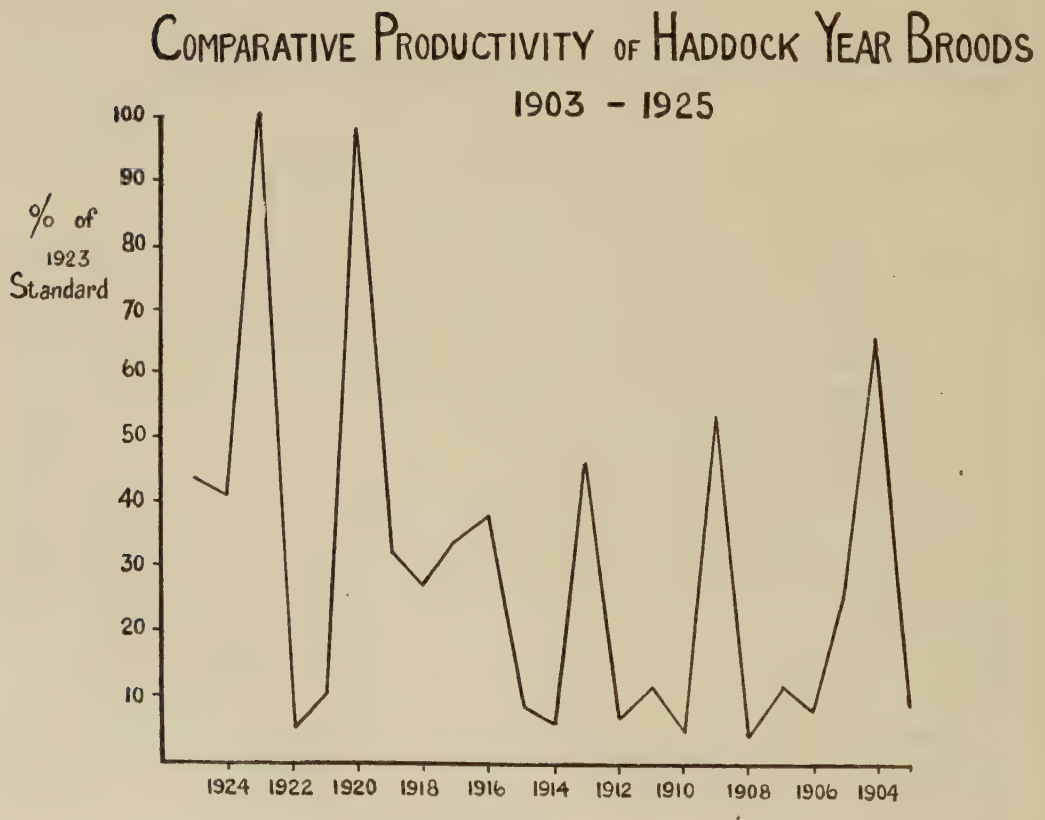
On all the available evidence therefore the probable migrations outlined are supported.

Fluctuations in the Annual Recruitment of Haddock Stock by New Brood.

Increasing attention is now being given to the estimation of the contribution each year's brood makes to the North Sea stock, since it is becoming more and more apparent that this is the most variable factor affecting the success of Haddock fisheries. The apparent variations are indeed so striking as to demand confirmation from as many avenues of enquiry as possible. Such confirmation has been forthcoming in such a positive manner as to remove all doubt that, from natural causes not yet specifically defined, there are great differences in the number of surviving brood Haddock between one year and another. In the extreme case a specially good survival year may apparently contribute twenty-five times the number of brood that an unusually poor year may. Natural variation of this order, occurring at source, places the question of "fishing out" or overfishing in a new light. The experience of recent years has been that provided a cycle of good to moderate brood years is experienced the severe pruning effect of the fisheries is more than counterbalanced although decreased weight of older Haddock caught is merely replaced by increased weight of younger Haddock. On the other hand a succession of poor to moderate brood survival years inevitably leads to an outcry on account of scarcity of Haddock and at such times attacks are made on the

present day methods and intensity of fishing. Since the war there has been an example of both a poor and a good cycle of brood years. Thus the years 1921 and 1922 produced a pair of broods almost negligible in numbers, and the years 1923—1926 excellent or at least moderate broods. In 1922, 1923 and the first part of 1924 the Haddock catches in the North Sea dwindled away to an unprofitable point, but from the latter part of 1924, when the splendid 1923 brood had reached a marketable size the average catch per unit for time has kept mounting up till the present date (winter 1926). In fact we are at the present time passing through, or have just passed through, a period of unusually productive years. There was a similar period in the latter part of the war period, but prior to that during the current century productive years tended to occur singly or in pairs at most.

The following graph is the result of an attempt to evaluate the survival value of the various year broods.



The most productive of a great number of years was that of 1923, and this was selected as a standard. The basis of estimation was the average number of Haddock of each brood caught per 10 hours' trawl fishing in all portions of the North Sea. In arriving at this average number the second year of life was utilised. Failing suitable second year date, the data for later years were utilised by modifying them by a previously determined factor, such that they were raised to the approximate numbers to have been expected in the second year of life. Again, in obtaining the final average from the averages of all the sub-areas the averages for the latter were weighted according to the size of area. Most of the year broods were not sampled in all the areas, and in such cases only the areas actually sampled were compared with the similar areas for the 1923 brood. For the latter years of the period when age determination has been more intensely carried out, the results are more dependable than those for earlier years, which had to be based largely upon observations in the western portion of the North Sea only. The graph is really largely in the nature of an experiment, as, in addition to the above difficulties, the standard year brood, 1923, had only completed its third year at the time these observations were made, whereas it would have been preferable to have as a standard a brood similarly well sampled but sampled throughout its existence down to old age. The results are, however, fairly trustworthy and present an eye picture of the various cycles to be expected over a long period. It will be seen that there have been five periods of high productivity alternating with four of low productivity. Prior to the war there were complaints about the scarcity of Haddock and the graph reveals that there had occurred just prior to 1913, two periods of poor survival (1906—1907 and 1910—1912) separated by only one productive year, 1909. That there were similar ups and downs in the period before these records commence is evidenced by Professor D'Arcy Thompson[1]. He states that there were two periods of exceptional abundance of Haddock — from 1886 to 1889 and from 1895 to 1896. On the other hand 1890 was a very lean year, and in 1893 complaints of scarcity were heard. 1901 was, according to the Montrose Trawling Statistics, a poor year for Haddock fishing but from 1901 to 1903 a glut of small Haddock appeared.

The Moray Firth fishing is intimately bound up with these events. There is little spawning within the Firth, and such as there is has little effect on the subsequent stocking of its waters. For example, in 1923 it was in the shallow inner reaches of the Firth, in from 10—20 metres of water, that the fry first grounded — in small numbers. This was in June, and, to prove that this is not the normal depth of water for first year Haddock, it was found that all had disappeared by October. However, following the more usual course of events, there were found in that month great shoals of brood Haddock advancing along the deep southern

[1] Report on the Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters. (North Sea Investigation Committee, 1902—1903).

channel. These had been spawned outside the Firth which must be regarded as deriving by far the greater part of its stock not from local spawning but by migration. Preferring deep water in very early life these Haddock did not populate the inner shallows in the first year, but after a short seaward migration in winter they swarmed all over the Firth in the second and third summers. A study of the data (for such years as it exists) reveals the following variation in the date of first entrance of appreciable numbers into the Firth:—

	Total
Broods entering Firth in first summer 1923, 1921, 1919, 1913, 1910, 1909, 1907....	7
Broods entering Firth in second summer 1926, 1925, 1924, 1920, 1906, 1905, 1904, 1903	8
Broods entering Firth in third summer 1922, 1912, 1911, 1908, 1902.....	5

Now apart from magnitude of numbers the various broods also vary in regard to the portion of the North Sea they colonise in their first year. The normal location is the whole area east of Scotland with sometimes a more northerly, sometimes a more southerly bias. Occasionally, however, a brood is successful only in more northerly and easterly districts. Obviously the location in the first year will affect the time when the Moray Firth will be reached by migrants. On the average, however, this occurs in the second summer. In the third winter there is a general exodus to the spawning grounds, and only a partial return after spawning. This recurs in successive winters until by about the sixth the history of any one brood as far as the Moray Firth is concerned is practically complete. Indeed the main body of the population always consists of second and third year Haddock. Some of these return after spawning but there is a general trend northwards to the Orkneys (and even the Shetlands in later years). The northward movement may even commence in the second year. Thus it was observed that in 1923 there were very few brood fish on the north-west side (west of Orkney to the Butt of Lewis). This brood could, however, be traced pushing its way round (from the outer Moray Firth winter concentration) via the Pentland Firth in the next summer and was thereafter always to be found on the west side. That there is a reciprocal move south into the Firth from Orkney and Shetland each autumn seems clear from a study of the scales. So that after first spawning occurs mixture of types becomes more and more common. The net result is that the Firth loses more Haddock to the north than it gains from it, but a corresponding northward migration of East Scottish Haddock compensates for this to some extent. This movement was clearly traceable in the case of those 1923 brood Haddock which spent the years of adolescence in the East Scottish Bight (including the Firth of Forth). In winter 1925 they had reached the latitude of Aberdeen and they spawned up to 40 miles N. E. of Buchanness. The following winter found them in a shoal lying east of the north Moray Firth and Orkney. This may well prove to be the normal latitude of the westerly portion of the body of a brood which has spawned once

and is about to spawn again, and be a half-way station to the more northerly stations reached in later years of life. (The fishermen of the north Moray Firth coast obviously have the better of their southern brethren from the point of view of proximity to older shoals). Old Haddock — of over 6 years of age — only occur sporadically as nomads in the Moray Firth.

Such Haddock marking experiments as have been carried out to date entirely support these conclusions.

Line Fishing in the Moray Firth during the period 1904—1916 (incl.)

by

A. Bowman, D. Sc.

The Data.

Although statistics of the quantities of fish caught by line and landed at the various Moray Firth ports are available for a long period of years, it is unfortunate that except during the period 1904—1916 (incl.) no distinction was made between the three methods of line fishing employed. Such detailed information would have possessed special value since the three methods of line fishing engaged in by the fishermen to-day, namely, great line, small line and hand line fishing, are prosecuted from the same ports and practically on the same fishing grounds as in pre-trawling days.

Great lining is carried on mainly by larger vessels fishing usually at a distance from their home ports for the larger individuals of such species as cod, ling, halibut, skate etc. while small line and hand line fishing are prosecuted, as a rule, in the near neighbourhood of the ports where the catches are landed daily. Indeed, hand line fishing is carried on chiefly for codling in the immediate coastal zone. Of the species caught by small line the haddock is by far the most important, yielding the greatest average weight per shot. The fishery for this species is usually pursued in depths of less than 30 fathoms in the near vicinity of the port of landing. Some of the larger boats from ports on the south side on the Firth may cross to the north-west shore and to the vicinity of Smith Bank to shoot their small lines. In former years, especially when fish were scarce in local waters, large sail boats sometimes made long journeys to fishing grounds outside the Firth. In recent years while the installation of motor power has given greater mobility to the fleet of small line boats the fishing is still carried on mainly within the precincts of the Firth.

The accompanying chart (Fig. 1) prepared from information furnished by the local Officers of the Fishery Board for Scotland indicates as clearly as possible the loci of the grounds fished by the various methods.

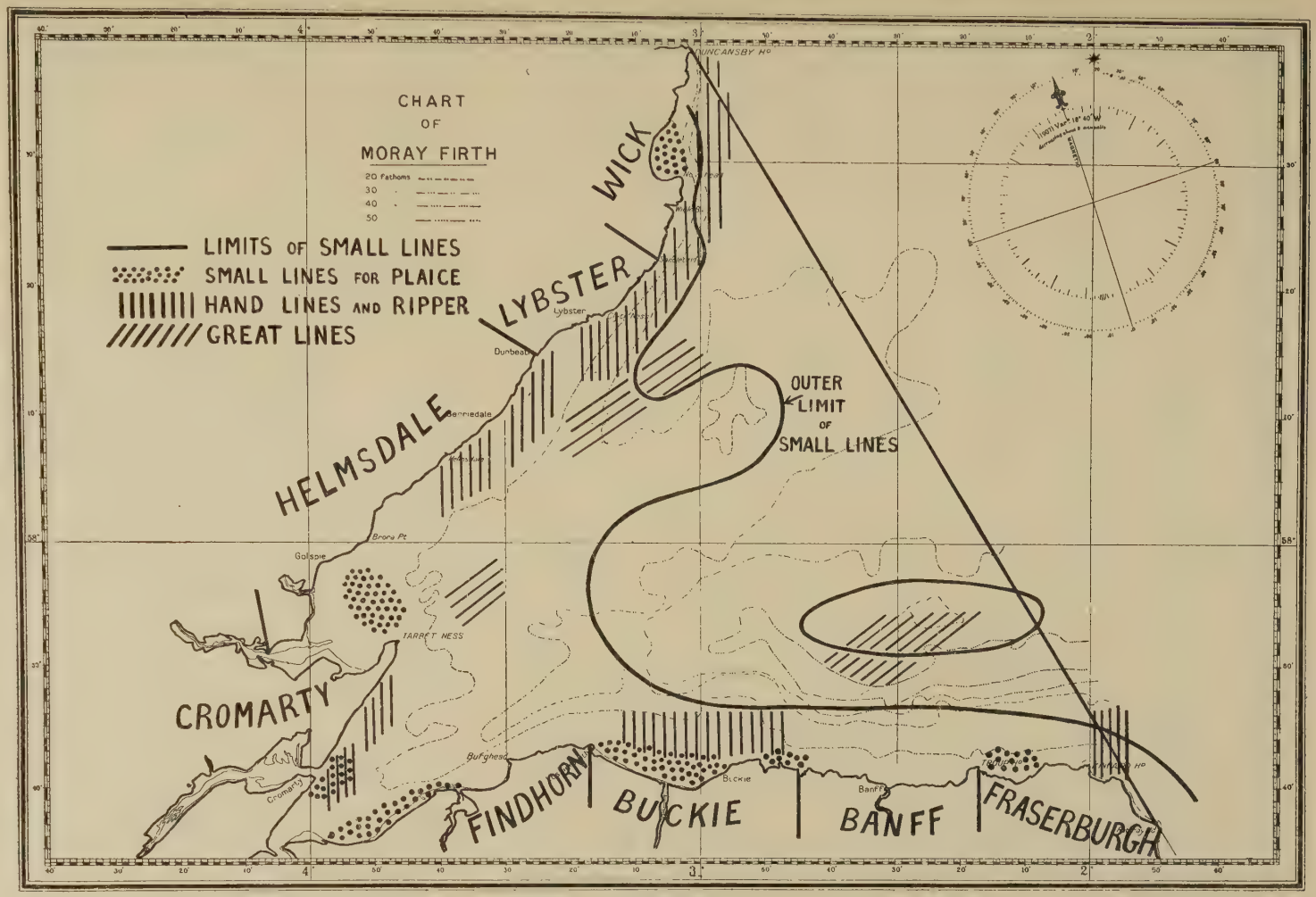


CHART
OF
MORAY FIRTH
20 Fathoms
30
40
50
LIMITS OF SMALL LINES
SMALL LINES FOR PLAICE
HAND LINES AND RIPPER
GREAT LINES
WICK
LYBSTER
HELMSDALE
OUTER
LIMIT
OF
SMALL LINES
CROMARTY
FINDHORN
BUCKIE
BANFF
FRASERBURGH
DUNCANSBY HD
Lybster
Dunbeath
Berriedale
Brora Pt
Golspie
TARBET NESS
Cromarty
Burghead
Buckie
Banff

Fig. 1.

As the three methods of line fishing are quite distinct from each other only the statistics for the years in which they were distinguished can be utilised with any degree of confidence to ascertain the nature and extent of any changes taking place in the composition of the stock of marketable species within the Moray Firth area.

During the period 1904—1916 (incl.) such a distinction was made in the statistics collected by the Fishery Board for Scotland at the Moray Firth ports and in addition the weights of the different species caught within the area were distinguished from those caught without the precincts of the Firth.

The statistics were collected by the Officers of the Board in charge of the seven districts Banff, Buckie, Findhorn, Cromarty, Helmsdale, Lybster and Wick so that comparable data are available from these different districts. For the sake of conciseness of treatment and at the same time to retain, as far as possible, any seasonal characteristics, the appropriate data have been combined in monthly periods.

These statistics, the most complete and probably the best of their kind from any area over such a lengthy period, provide information as to the numbers of shots landed at the various ports, the species caught and the total weights and values of each species landed. In the case of the haddock, the various categories such as large, medium and small are distinguished and a distinction is also made between cod and codling. There are no fixed standard lengths for these categories, however, and the connotation of the terms varies from port to port and even at the same port from time to time. Plaice and flounders are not always clearly distinguished from each other, especially in the earlier years. The total quantities of these two species caught by lines are, however, small.

Changes in the Line Fishing.

Although the actual methods of line fishing are those which have been in use from very early times, the conduct of the line fishing in the Firth has undergone great changes during the last thirty years. The chief contributory factor to these changes has been the introduction of mechanical propulsion into the fleet.

Generally speaking, for the great majority of the fishermen all other methods of fishing including line fishing are supplementary to the herring fishing and are to be regarded as auxiliary means of obtaining a livelihood. The rapid introduction of the steam drifter into the herring fishing at the beginning of the century enabling the fishermen to pursue the herring fishing in distant waters for longer periods had therefore a considerable effect on the economic importance of the line and other fishings in the Firth itself.

It was not until 1912 that motor boats were used in the line fishing but after that date an increasing number of the small boats engaged in line fishing had motors installed.

The period 1904—1916 (incl.) for which the detailed statistics for the line fishing are available may therefore be considered as a transition period with respect to the introduction of mechanical propulsion.

The following account of the line fishing operations, based chiefly on information furnished by the officers in charge of the various districts, describes briefly some of these changes and the position at the present date.

(a) Great Line Fishing. For many years previous to 1900 great line fishing was carried on concurrently with the winter herring fishing. It was then of considerable importance and gave employment to a large number of fishermen during the early months of the year. The grounds within the Moray Firth usually fished were chiefly in the area from Tarbet Ness to Clyth Ness from 3 to 10 miles from the Sutherlandshire coast.

After the introduction of steam into the herring fleet fishermen began to devote more of their time to the capture of herrings, and when cod-net fishing was introduced, great line fishing was gradually abandoned in the Firth and now there are only a few fishermen who make occasional catches by this method.

At Fraserburgh only 25 local steam and motor boats operate outside home waters. During recent years, however, fishing in home waters has been confined to about six half-sized motor boats which generally fish from March till July within the limits of the Firth. The continuance of great line fishing during the summer is a recent innovation and may be said to have arisen as a result of the backward seasons experienced at herring fishing and from the fact that it can be carried on at less initial expense.

Great line fishing was never a popular method in the Banff district except with some of the fishermen from Gardenstown whose operations, however, are carried on almost entirely outside the limits of the Firth, mostly on the West Coast of Scotland.

There are now no fishermen operating with great lines from the Buckie district and the fishing may be said to be extinct there.

Previous to 1900 great line fishing at Findhorn was prosecuted to a much greater extent, but after that year a decline set in and with the advent of cod-net fishing this became more accentuated. Only about six motor boats manned by 24 fishermen may now be employed at this branch of the fisheries especially when hake are expected to be found on the Moray Firth grounds. Operations are carried on from April to September, catches consisting of hake, ling, halibut and skate.

From the Cromarty district about eight boats work at great line fishing during the winter and spring months but the number depends on the success which attends the small herring and sprat fishery in the Inverness and Cromarty Firths. Catches consist mostly of cod and skate.

Since 1900 very little has been done at great line fishing in the Helmsdale district and this branch of the fishing is now practically non-existent there.

Prior to 1900 a considerable amount of great line fishing was carried on from the Wick and Lybster districts but now the fishermen rarely shoot a great line their energies being concentrated on herring, "ripper" and hand line fishings.

(b) Small Line Fishing. At Fraserburgh about the beginning of this century small line fishing for haddock was undertaken by crews with large sail boats. As the larger boats were gradually abandoned, however, a number of crews adopted a smaller size of boat into which motor power was eventually installed. These smaller boats, some 17 in number and employing 80 men, fish on more or less restricted grounds 3 to 5 miles offshore between Kinnaird Head and Rosehearty and 12 to 16 miles in a north westerly and northerly direction.

Small line fishing is carried on with greatest intensity from the Banff district. While it is carried on all the year round the principal season is from September to May (incl.). Most of the fishing takes place on the nearer grounds but some of the larger boats cross to the north-west shore and to Smith Bank.

During the last few years small line fishing has received very little attention in the Buckie district. It is now prosecuted by a few crews of elderly fishermen who fish on the inshore grounds one to five miles from land.

In the Findhorn district small line fishing is prosecuted from all the creeks of the district during the whole year and a fleet of 49 motor boats manned by 225 fishermen is usually employed. Operations are conducted chiefly on the inshore grounds about one to eight miles off the coast.

Small line fishing is the principal branch of the fisheries of the Cromarty district and is carried on throughout the whole year. The best catches are usually obtained during the last four months of the year, while the highest catches are secured by the motor boats operating on the offshore grounds.

This method is also by far the most important in the Helmsdale district where it is prosecuted at each of the creeks to a certain extent all the year round. Helmsdale is the chief centre of the fishing, and the catches of the small line boats are usually considerably better there than at other creeks in the district mainly because of the fact that the Helmsdale men use a greater number of lines and have better vessels than the men of the outlying creeks. The number of fishermen engaged in small line fishing ranges from about 190 in the first and last quarters of the year to about 100 in the other two quarters. During the latter period a number of the district fishermen engage in herring fishing mainly on vessels owned in other districts. Helmsdale motor line boats regularly frequent Smith Bank during the summer months.

In the Wick district the small line areas are the whole of Sinclair Bay and an area one to six miles off Clyth Ness and extending along the coast as far south as Dunbeath. Small lines are worked all the year round in Sinclair Bay by a small number of men who owing to the sheltered position of their fishing ground can usually follow their calling much more regularly than is possible for the fishermen

who have to fish on grounds not so favourably situated. In the Clyth Ness area where more men are employed the fishing is carried on for ten months of the year (April to January) except when inshore herring fishing might engage the attention during the months of August and September. As a rule the fishing is irregularly prosecuted in the Clyth Ness area owing to weather conditions.

At certain places in the Moray Firth a special fishing is carried on for plaice. The areas thus fished are indicated on the chart. The fishery, which is relatively unimportant, is carried on in the inshore waters mainly from February till May.

Changes in the Small Line Fishing.

The methods of small line fishing which have been handed down from generation to generation have undergone no essential change. Each member of a crew provides a quota of the lines and hooks used, but the number of lines supplied by each, their length and the number of hooks vary from place to place. Mussel is the principal bait used in the haddock fishing but herring, if available, may be substituted in season. Limpets are sometimes employed when mussels are scarce and in some districts buckies may be employed occasionally. For the capture of flatfish in the sandy bays in spring and summer the lines are baited with lug-worm.

Probably the most important change which has taken place has been the installation of motor power into the boats. The adoption of this mechanical aid to the fishing has brought about various other changes. It has greatly extended the scope of the operations; the motor boat fishermen has a wider choice of grounds and can carry on his operations more regularly than in the days of the sail boat.

The extent and rapidity of the change from sail boats to motor boats in the different districts are shown in the accompanying table (pag. 92) wherein are given the total number of landings each year by small line boats and the percentages of these ascribed to the activities of the motor boats. The initiative was taken in the Banff district in 1912 when three per cent. of the shots were landed by these craft. The change over in the district from sail to motor was very rapid; by the year 1916 more than half the landings were made by motor boats while in 1920 the use of the sail boat in the small line fishing had been almost completely abandoned. Motor boats were also employed in the small line fishing at Helmsdale for the first time in November 1912. Motors were soon installed in the larger and better class of boats and by the year 1918 over half of the landings were being made by these boats. The conversion of the fleet was not so complete as in the Banff district and a few of the smaller sail boats still continue the small lining from some of the smaller creeks of the district.

In the Findhorn district where small line fishing is relatively of considerable importance motor boats were not employed at this method of fishing until June 1914 but thereafter the conversion of the fleet was very rapid, almost 63 per cent.

Small Lines.

The Introduction of Motor Boats into Small Line Fishing.

	Banff		Buckie		Findhorn		Cromarty		Helmsdale		Wick & Lybster	
	No. of Shots	% by Motors	No. of Shots	% by Motors	No. of Shots	% by Motors	No. of Shots	% by Motors	No. of Shots	% by Motors	No. of Shots	% by Motors
1912.....	7546	3.03	—	—	—	—	—	—	—	—	—	—
1913.....	4431	23.2	—	—	—	—	—	—	3439	5.96	—	—
1914.....	7461	33.6	4256	0.5	—	—	—	—	2915	3.1	—	—
1915.....	9996	34.5	3249	0.3	8392	0.1	—	—	4061	10.3	—	—
1916.....	9354	52.7	2935	0.8	8110	6.3	—	—	3693	22.6	—	—
1917.....	9540	60.3	2014	1.4	10729	30.4	—	—	4509	41.8	—	—
1918.....	11597	75.0	1420	8.5	13239	62.7	—	—	5205	57.5	—	—
1919.....	11588	86.2	2370	8.7	10661	79.2	4747	8.6	3961	74.9	537	77.1
1920.....	8754	97.2	2387	13.2	10155	89.6	5209	13.6	4313	68.8	558	89.4
1921.....	10340	91.1	2707	10.3	13097	93.9	5642	25.4	5034	72.2	1077	78.1
1922.....	9322	98.1	2329	8.9	12041	98.9	6716	24.9	5198	70.9	938	82.1
1923.....	7376	97.9	1729	9.0	9343	97.7	4873	47.1	4180	89.0	446	76.2
1924.....	4986	98.1	948	1.2	6097	96.4	4936	44.5	3041	85.8	691	88.5
1925.....	4596	100.0	1005	0.9	8023	96.1	6117	35.6	3751	80.5	1078	92.2

of the landings in the district in 1918 being accomplished by motor boats and after 1921 the number of small sail boats engaged in this method of fishing was negligible. In the northern districts of Lybster and Wick where small line fishing is not carried on to any great extent motor boats were not introduced until 1919 but from that year onwards the greater proportion of the landings was made by motor boats. At Cromarty it was comparatively late before motor boats were employed at small lining, the first landings being made in July 1918. In this district, however, the change has not been complete and the small line fishing is still prosecuted by a number of small sail boats. Since 1914 Buckie has gradually declined as a small line fishing centre, the fishing now being mainly carried on by a few small sail boats. It is not to be concluded that the fishermen of the Buckie district were less ready to instal motors, but that few of the boats so equipped were engaged in the small line fishing.

Before the advent of motor power many of the larger class of sail boats carrying 6 to 7 men engaged in the haddock fishing but, there has since been a tendency, where sail boats do persist, to employ only the smaller class. Fewer men are employed on the motor boats than on the larger class of sail boat. As each man still supplies his quota to the fleet of lines these changes have also involved modification of the number of hooks employed.

In the Banff district only motor boats carrying 4 or 5 men and a boy are now engaged in the small line fishing. Each man supplies four half lines with 480

hooks on each half line. The total number of hooks shot by each motor boat of this district is therefore, approximately, 9600 in the one case and 5760 in the other. Before the introduction of motors the average number of half-lines carried on each boat was two less than obtains at present.

At Buckie each man contributes 1000 hooks to the fleet of lines. Before the introduction of the motor boat the large sail boats manned by 6 or 7 men therefore had an average of 6000 or 7000 hooks. With the replacement of the larger sail boats there has been a reduction in the average number of hooks employed, the smaller class of sail boat averaging about 3000. The average number of hooks employed by the motor boats is about 5000.

Previous to the introduction of motors into the Findhorn district in 1914 the conditions were similar to those at Buckie. At the present day very few sail boats are employed at small line fishing and these are small, carrying 2 or 3 men with an average of 2400 hooks per boat. The motor boats are equipped with an average of 5000 hooks but this number may be reduced to 4000 in winter and increased to 6000 in summer.

In the Cromarty district boats carrying four men work 8 lines, the number of hooks per line varying from 600 to 700. Prior to 1914 these boats carried 12 lines each with 600 hooks and made three trips weekly to offshore grounds. Using only 4800 hooks they now confine their operations to nearer waters and land their catches daily. Small sail boats with 2 of a crew fishing close inshore use on an average 1200 hooks. Sixteen lines per vessel with an average of 7000 hooks are now employed by the motor boats at Helmsdale. The motor boats manned by 4 of a crew each with 4 lines per man, have generally replaced the large sail boats with 5 or 6 of a crew each with 3 lines per man. There has been little or no change in the number of hooks employed. The small sail boats which now engage in the fishing are equipped with about 4000 hooks each.

Very little small-line fishing is carried on either in the Lybster or Wick districts and only by small boats. In the Sinclair Bay area the crews consist of two to four men and each man supplies two lines so that the number of hooks used per boat ranges between 1600 and 3200. The small sail and motor boats at Lybster employ about 1000 hooks. If the weather is unsettled only one line with about 600 hooks is used.

It should be noted that just as the introduction of motors to the fishing was gradual, so were the changes with regard to the number of hooks employed. In the period to be reviewed motor power had not been introduced to any great extent. The number of landings or shots and the calculated average weights of fish caught per shot by each method therefore provide the best available indices of the intensity with which the fishing was carried on and of the abundance of fish on the grounds from month to month.

(c) Hand Line Fishing. Hand line fishing is a coastal fishery, the principal localities fished being situated along the north-west shore of the Firth. It is carried on most vigorously in the Wick district by a considerable number of fishermen throughout the whole year.

"Ripper" fishing is a form of hand line fishing and the two methods are sometimes in operation at the same time. The fishermen sometimes bait the hooks of the "ripper" with mussels or limpets. When the "ripper" fails to capture, it is taken off the line and replaced by a bait hook, and *vice versa.*

The number engaged in the "ripper" fishing in the Helmsdale district, chiefly from Helmsdale and Dunbeath, is about 30 and a considerable proportion of these are old men. This fishing is engaged in principally in the summer months, as during the winter weather conditions are seldom favourable enough for successful operations.

In the Cromarty district hand lines are but little used and in the Findhorn district this method of fishing is not carried on at all.

At Buckie, however, hand line and "ripper" fishing are the only branches of line fishing which receive much attention. These methods are prosecuted regularly during the summer months and in a desultory way throughout the rest of the year with favourable weather, chiefly by elderly fishermen who are unable to follow the herring fishing and who stay at home mending nets and fishing as opportunity offers. The same fishermen use both methods on the same grounds from one to five miles from land.

In the Banff district "ripper" fishing has never been developed as a commercial proposition.

Down to the war years "ripper" fishing in the Fraserburgh district was looked upon as a pastime or a method of fishing suitable for old men. During the war years, however, it commanded considerable attention and since then it has continued to develop. Small motor boats were built for the purpose of prosecuting this particular method of fishing and from the port of Fraserburgh alone there are 31 small motor and 6 small sail boats employed from December to the end of May. Many of the men who man these small boats are the owners of steam drifters and after the close of the East Anglian herring fishing until the opening of the summer herring season a considerable number of small sail boats engage in "ripper" fishing.

The Number of Shots and the Total Quantity of Fish landed Yearly.

As may be seen from the last two columns of the table (p. 95) the line fishing of the seven districts to which the statistics apply is not carried on exclusively within the precincts of the Firth. For the whole of the period under review 20 per cent. of the line fish landed were caught beyond the limits of the area. If, however, Wick district, which extends outside the Moray Firth along the north coast of Scotland as far as Cape Wrath, is excluded from the table, it is found

Line Fishing 1904—1916 (incl.).
Yearly Landings and Total Weight caught by each Method.

Year	Great Lines			Small Lines			Hand Lines			Total from Moray Firth (cwts.)	Total All Sources (cwts.)
	Landings	cwts.	%	Landings	cwts.	%	Landings	cwts.	%		
1904.....	690	3611	3.9	32863	74566	79.6	10102	15471	16.5	93648	137435
1905.....	584	2269	2.7	31542	67367	81.4	9806	13186	15.9	82822	125094
1906.....	612	4855	5.0	29742	79587	82.2	8371	12388	12.8	96830	127075
1907.....	709	4399	4.2	29854	89249	85.1	5972	11231	10.7	104879	126922
1908.....	283	1639	1.8	28922	79712	84.5	6984	12967	13.7	94318	117516
1909.....	398	1094	2.4	22007	50642	84.0	6533	8523	13.6	60259	77696
1910.....	255	747	1.0	23395	63799	83.2	6753	12134	15.8	76680	98992
1911.....	120	571	0.5	29755	91859	77.5	8367	26071	22.0	118501	135925
1912.....	365	1918	1.5	30486	97013	79.8	7462	22684	18.7	121615	141245
1913.....	258	1072	1.6	21473	59774	85.9	4073	8718	12.5	69564	85219
1914.....	225	940	1.3	24815	57515	83.9	5264	10116	14.8	68591	79110
1915.....	61	290	0.3	31273	81531	86.8	6931	12122	12.9	93943	101002
1916.....	77	233	0.3	31317	78357	87.6	5135	10816	12.1	89406	103158
	4637	23638	2.0	367444	970971	82.9	91753	176427	15.1	1,171036	1,456389

that the total quantity landed within all other districts amounts to 1,091,487 cwts. of which 1,064,585 cwts. or 97.5 per cent. was caught within the area. Hence most of the fish caught by lines beyond the limits of the Firth are landed in the Wick district and the line fishing from the other districts is confined to Moray Firth waters, though in some years some vessels may go further afield in search of fish. In 1904 steam vessels from the Findhorn district pursued the great line fishing on more northern grounds and owing to their efforts the quantity of cod and skate landed exceeded that of the previous year. In the year 1905 the large sail boats fishing from the port of Buckie went long distances in search of fish, very frequently shooting their lines off Copinshay, Orkney.

The total quantity of fish of all species caught by lines within the area during the period 1904—1916 (incl.) was 1,171,036 cwts. If the three war years be excluded from consideration, the total for the ten year period (1904—1913) was 919,116 cwts. or a mean annual weight of 91,912 cwts. The fluctuations from year to year ranged from 34 per cent. below to 32 per cent. above the mean. The years 1909 and 1910 were poor years in which the total weights caught were 34.5 and 16.6 per cent. respectively below the mean for the period but these two lean years were followed by two brighter years 1911 and 1912 when the total catches rose to 28 and 32 per cent. respectively above the mean.

The above Table and Fig. 2 show that it was the small line section of the

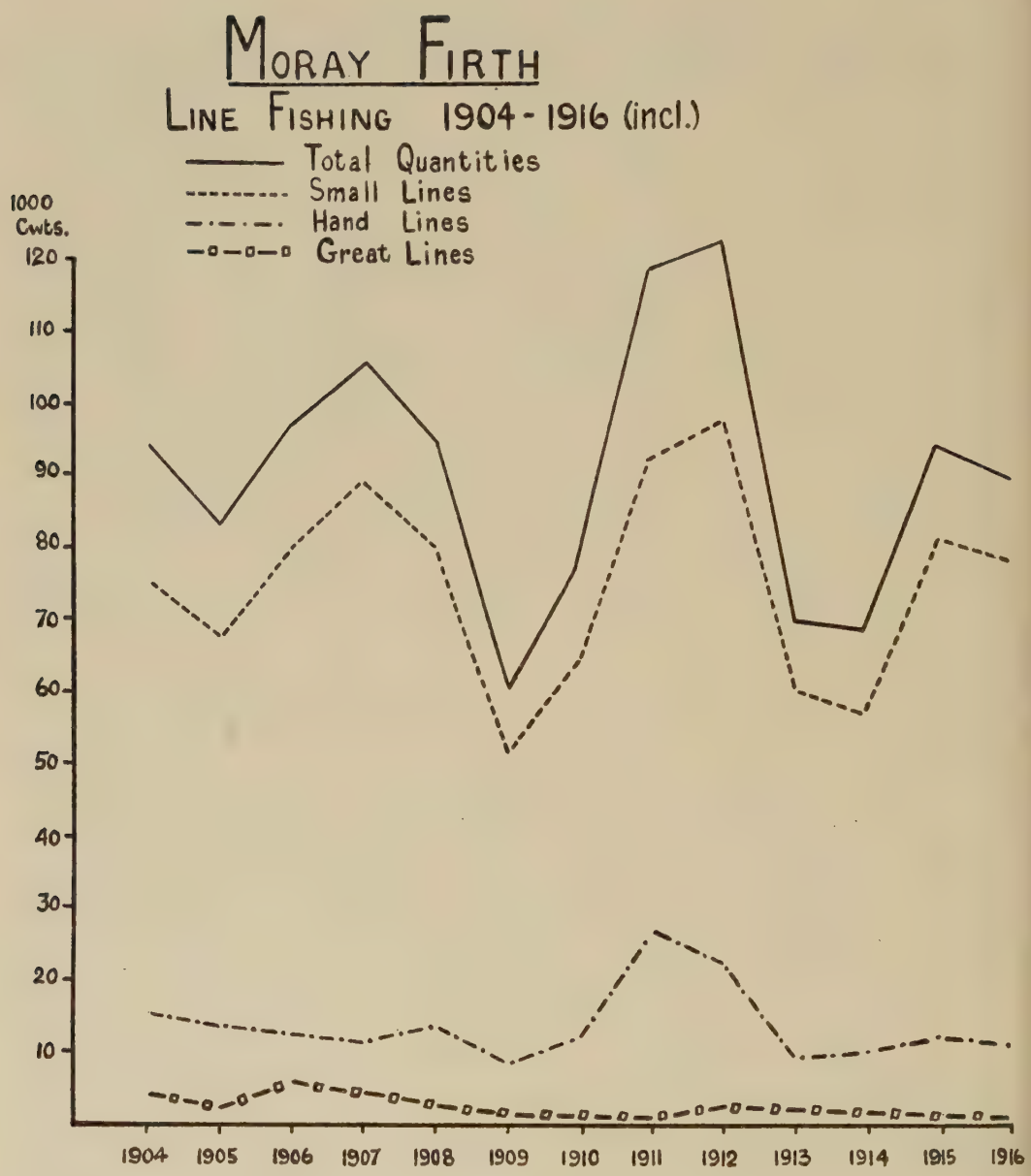


Fig. 2.

fishing which contributed by far the greatest weights to the catches, the mean annual weight of fish landed by this method being 75,357 cwts. or an average contribution of 83 per cent. to the total weight of all fish caught by lines. The fluctuations in

the total yield of the line fishing is to be attributed mainly to the success or otherwise of the small line fishing.

On the other hand the quantity of fish caught by great line during the period under review was insignificant, the mean contribution being only two per cent. of the total quantity. The decrease from 3611 cwts. in 1904 to 233 cwts. in 1914 was accompanied by a marked falling off in the number of shots. In 1906 when the landings by great lines were heaviest they reached only 5 per cent. of the gross total weight, while by the end of the period the weight attributed to this method had fallen to less than one per cent.

The quantities caught by hand lines for the different years did not vary greatly and the average contribution was approximately 15 per cent. of the gross total. The best year was 1911 when a total of 2600 cwts. constituted 22 per cent. of the total weight of line fish.

The District Contributions.

The statistics of landings show that not only was the line fishing carried on with different degrees of intensity from the separate districts but that the share contributed by the different methods of fishing to the total landings of each district varied greatly. In short, each district has its own characteristic methods of prosecuting the line fishing. In the following tabular statement the last two columns show the relative importance of each district and the share contributed by each of the three methods to the total landings within each district.

The Fishery Districts along the south shore of the Moray Firth are the most important centres for the line fishing. Banff maintained its premier position through-

Line Fishing 1904—1916 (incl.).
District Totals and Percentage Contributions by each Method.

Fishery District	Great Line cwts.	%	Small Line cwts.	%	Hand Line cwts.	%	Total 1904—1916 cwts.	Mean % Contribution by each district
Banff	1091	0.38	285466	99.00	1780	0.62	288337	24.61
Buckie	1998	1.16	153117	88.66	17573	10.18	172688	14.75
Findhorn	2149	1.04	205901	98.96	—	—	208050	17.77
Cromarty	266	0.15	171113	94.71	9275	5.14	180654	15.43
Helmsdale	5019	2.87	131829	75.30	38211	21.83	175059	14.95
Lybster	1373	3.45	14830	37.26	23595	59.29	39798	3.40
Wick	11742	11.03	8715	8.19	85993	80.78	106450	9.01
Total, All districts	23638	2.0	970971	82.9	176427	15.1	1,171036	—

out the period and only in 1913 when only 17.48 per cent. of the total fish was landed in that district was there a slight set-back. The two most northerly districts of Wick and Lybster are the least important. It is evident from the data that during the period reviewed the relative importance of the contributions to the total supply from the Helmsdale and Findhorn districts gradually improved, while the opposite tendency was shown at Cromarty and Buckie.

The Separate Districts.

If the total quantities landed within each Fishery District are considered separately a general similarity is noted in the course of events. The success or failure of the fishing in any one district synchronises more or less closely with the course of events in the other districts. As was shown for the whole of the districts combined, the yield for the years 1909 and 1910 was distinctly below the mean for the period and these two bad years were succeeded by the two good years 1911 and 1912. This phenomenon was apparent for each district although the fluctuations were more violent in some districts than in others. There is no doubt therefore but that some common cause or causes were in operation bringing about these simultaneous changes.

Banff.

The accompanying table (p. 97) shows at a glance that small line fishing was the method employed almost exclusively in the Banff district. Ninety-nine per cent. of the total weight of fish caught by line was attributable to this method and the contributions in no year fell below 97. Great lining and hand lining are negligible factors in the supplies, and the prosperity of the line fishing at Banff is due entirely to the results obtained from the small lines.

Buckie.

As a line fishing centre Buckie was much less important than Banff, for, while the average contribution by Buckie to the total line fish caught in the Moray Firth was approximately 15 per cent. that by Banff was nearly 25 per cent. While small line fishing was the most favoured method, hand line fishing also received some attention. Except in the last year of the period (which may be abnormal) the hand line fishing declined in relative as well as in absolute importance. After 1908 great line fishing practically ceased to be carried on from the district and only in 1904 did the landings from great lines reach 4.5 per cent. of the total weight of line fish landed.

Findhorn.

Just as at Banff, small lining was the principal method of line fishing. No hand line fishing is recorded as having been prosecuted within the district and no great line shots were landed in eight of the years of the period under review. Only in one year, namely 1907 were the supplies landed from great lines of any significance. In that year 1333 cwts. or 6.41 per cent. of the total weight of line fish were caught by great lines. It may be noted here that the cod-net fishing which started in 1906 was carried on with greatest vigour in the early years from ports in the Findhorn district.

Cromarty.

Small line fishing was also relatively most important in this district and provided an average of almost 95 per cent. of the total weight of fish and never in any individual year was the contribution less than 90 per cent. In no year was great line fishing prosecuted with vigour and only in 1904, the best year, did the weight of fish caught by great line amount to one per cent. of the total. In later years the amount was negligible and great lining may be said to have ceased to exist in the district.

Helmsdale.

All three methods of line fishing were carried on at Helmsdale. Small line fishing was, however, the most important, with an average contribution to the weight of fish landed in the district of 75.3 per cent. The percentages for hand lines and great lines were 21.63 and 2.87 respectively. There was a tendency for the hand line fishing to increase in relative importance, with a corresponding decline in the great line fishing. The percentage yield from small lines varied considerably; in 1913 it reached 83 per cent. of the total line fish landed, while in 1911 it was as low as 49 in a year when no great line shots were landed. The year 1911 may therefore be noted as one in which increased attention was given to hand line fishing at Helmsdale. It should be observed, however, that 1912 was the year of relatively greatest importance for the great line fishing.

Lybster.

The total quantity of line fish landed within the Lybster district is extremely small, amounting to only 3.40 per cent. of the total for all districts. All three methods of line fishing are prosecuted, but there is here a great contrast with regard to the relative importance of the different methods as compared with those used on the south side of the Firth. To the small total weight of fish landed, hand lines contributed the largest share and only in 1912 was the share less than half of the total weight. The mean percentage for the period was 59, but in 1911 it reached as high as 75.5 per cent. It may be remarked that this is the year in which increased attention was given to the hand line fishing in the Helmsdale district.

Great line fishing was of little or no importance; the landings have declined so steadily that it would appear as if this method is being discarded altogether.

Small lines caught only 37 per cent. of the total weight of fish although in the different years the proportions varied from 24 per cent. of the total in 1911 to 54 in 1912. In contrast to Helmsdale no great line fish were landed in the year 1912.

Wick.

As already stated the fish caught by lines beyond the limits of the Firth bulked more largely in the catches landed in Wick than in any other district. The following are the percentages of the total landings which were caught within the Firth in the respective years.

Year	1904	1905	1906	1907	1908	1909	1910
Percentage caught within the Firth .	26.8	19.7	28.1	27.2	25.5	23.8	21.9

Year	1911	1912	1913	1914	1915	1916	(1904—1916)
Percentage caught within the Firth .	**39.2**	**41.4**	28.5	32.1	44.8	28.3	29.2

Less than one-third of the total line fish landed in the district came from within the precincts of the Firth. If the war years are omitted it will be noted that the share contributed by fish caught within the Firth was high in the years 1911 and 1912.

With regard to the methods of line fishing carried on within the Firth from this northern district, hand lines are most favoured and during the period reviewed the weight of fish landed as a result of operations was 81 per cent. of the total, the remainder being shared by the great and small lines. The great lines contribute a slightly bigger aggregate than the small lines. There is an indication, however, that in this district there is also a tendency for great lining within the Firth to fall into disfavour. The amount of small line fishing carried on at Wick, although insignificant, appeared to maintain its relative position. The yield from the hand line fishing was best both relatively and absolutely in 1912 in contrast to the Lybster and Helmsdale areas where the best returns were made in 1911.

Summary.

The small line fishing is the mainstay of the line fishing in the Moray Firth area, the haddock species being the main object of the fishery. It is prosecuted from all the districts within the Firth but is carried on with greatest vigour at Banff. At Wick it is of insignificant proportions.

Hand line fishing is a purely coastal fishery carried on chiefly for codling. It reaches its highest development along the north-west coast, Wick being the chief centre. It is a method of fishing not much favoured along the south shore except in the Buckie district where, however, it is not prosecuted with any great vigour.

The amount of great line fishing carried on within the Firth is almost negligible. There is a tendency for this method — even in the Wick district where it is carried on with greatest vigour — to become obsolete.

The Intensity of Fishing.

The Number of Landings.

As the three methods of line fishing are quite distinct from each other the statistics as to the number of shots made each year are considered separately. These are given in detail in the table on p. 95. The accompanying diagram (fig. 3) shows clearly the trend of events within the period under review. While the number of shots provides a fair measure of the intensity of fishing it must be remembered that variations may be due partially at least to weather conditions. Most of the boats employed in the fishery were sail boats; motors were installed only in a few of the boats towards the close of the period.

Great Lines.

It is evident from the diagram that one reason for the decline in the total quantities landed annually from great lines was diminished effort on the part of the fishermen. The tendency to abandon great lining in the Moray Firth is evident in the statistics of all the districts. The average number of shots landed per year at Wick where activity was greatest was 204; the average for the first five years (1904—1908) was 321 and for the last five (1912—1916) 82. At Buckie, Findhorn, and Cromarty the total numbers of great line shots landed between 1909 and 1916 were 7, 6 and 6 respectively.

Small Lines.

The total number of shots by small line boats for the whole period was 367,444 or an average of 28,264 per year.

The shots landed in each district by small line boats during the whole period are shown below expressed as a percentage of the total number of shots for the whole Firth and illustrate the relative intensity with which the fishing was prosecuted in the various districts.

Percentage Number of Shots.

	Banff	Buckie	Find-horn	Crom-arty	Helms-dale	Lyb-ster	Wick	Total No. of Small Line Shots
% No. of Shots ..	27.3	13.8	24.8	20.5	11.7	0.8	1.1	367,444

The fishing was prosecuted with greatest energy in the districts of Banff, Findhorn and Cromarty; the amount of small line fishing carried on from the creeks

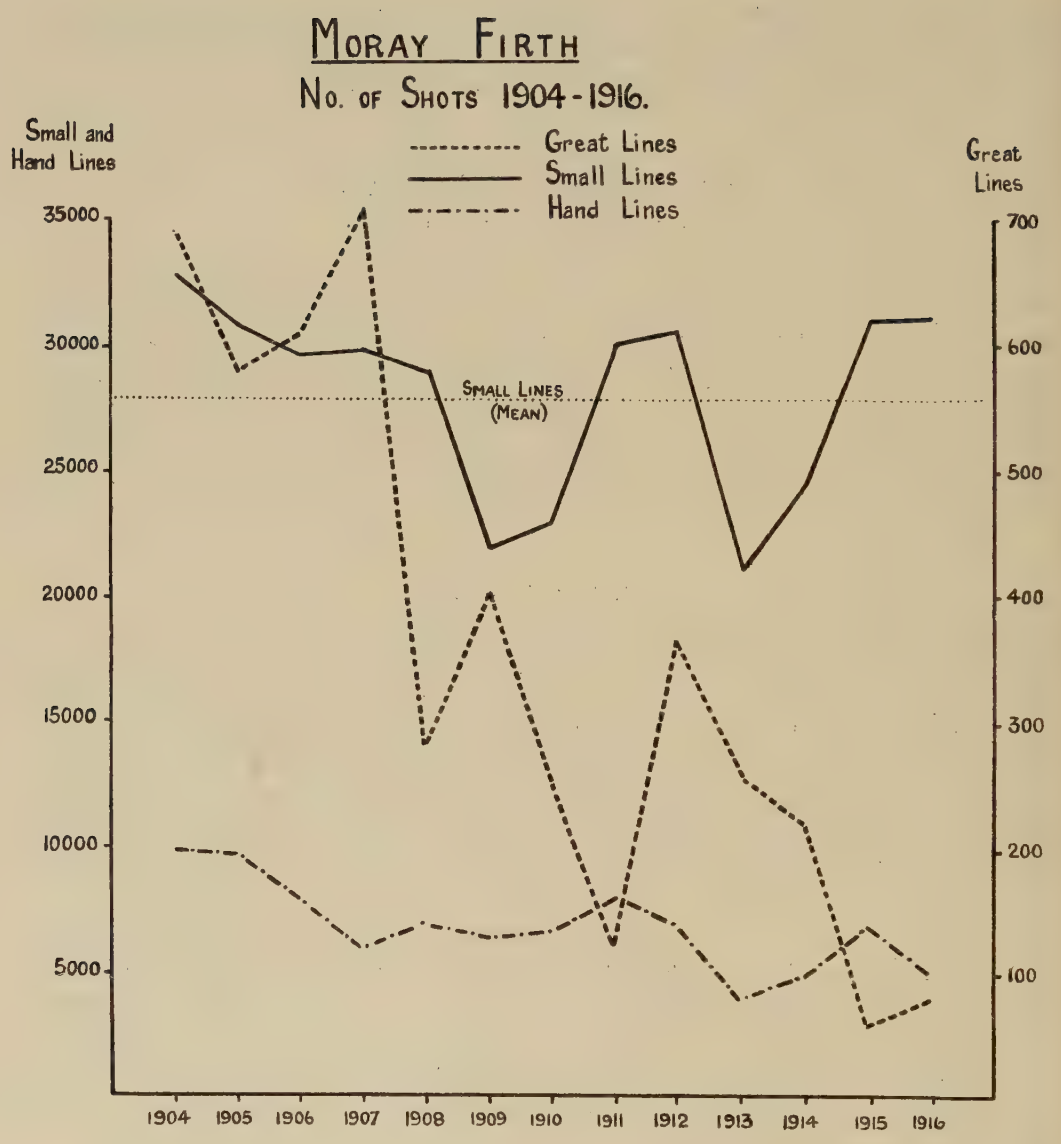


Fig. 3.

on the north-west shore north of Helmsdale was negligible, the number of shots landed there being less than 2 per cent. of the total.

The fluctuations in the total number of shots from year to year are probably not greater than one would expect from the nature of the fishery, but the period under consideration is too short to determine whether there was any tendency for the intensity of small lining to increase or decrease. In the years 1909, 1910 and

1913 the number of shots was low in all districts and these facts are reflected in the statistics of the total weight of fish landed. In the other years the numbers of shots are above the average. The numbers vary from 24 per cent. below to 16 per cent. above the mean, the variations occurring more or less simultaneously in all districts in the same direction.

Hand Lines.

An apparent decline in the intensity of fishing by hand lines was checked somewhat during the two good years 1911 and 1912. If the war years are ommitted from consideration the average number of shots per year for the first five years (1904—1908) was 8247 and for the second five (1909—1913) 6638. This method of fishing was favoured neither at Findhorn nor at Banff. No shots are recorded as having been landed at Findhorn and with the exception of 1915 and 1916 when 927 and 16 shots respectively were landed this fishing may be said to have been non-existent at Banff after 1908. In the Buckie district situated between Banff and Findhorn more attention was given to hand line fishing but here also there was a tendency for it to become less popular. The average number of shots landed at Buckie per year in the first five year period 1904—1908 was 2226, while in the five years 1909—1913 it was 898. It was along the north-west shore from Helmsdale to Wick that hand line fishing was relatively most important. The percentage contributions made by the separate districts to the total hand line shots for the whole period are as follows:—

Moray Firth — Hand Line Shots.

	Banff	Buckie	Findhorn	Cromarty	Helmsdale	Lybster	Wick	Total Shots 1904—1916
Percentage Shots landed	2.4	18.7	—	6.8	19.1	11.9	41.1	91,753

Thus, over 70 per cent. of the hand line fishing was carried on from the districts of Helmsdale, Lybster and Wick and the only section of the south coast where hand line fishing had any significance was at Buckie where 18.7 per cent. of the shots were landed.

Seasonal Variations in the Intensity of Fishing by Lines.

Line fishing was not carried on with uniform intensity throughout the whole year. Although there was no actual cessation of fishing there were times of the year, more or less defined for each method, when the fishing was carried on with the greatest intensity. It should be noted, however, that various influences such as scarcity or abundance of fish in the Firth, success or failure of competing methods of fishing etc. may affect the normal trend of the fishing in any particular year.

The weather too is an important factor which not only affects the number of landings of the smaller craft but when very stormy may also suspend the operations of the larger boats for a number of days.

For the period 1904—1916 (incl.) small line boats landed over four times as many shots as hand line boats. The total number of shots made by small lines was 367,444 while hand liners totalled 91,753. In the same period the number of shots landed by great line boats aggregated only 4637.

At all times of the year small lining was by far the most important method of line fishing.

The mean monthly variation in the intensity of fishing by each method is given in the following table in which the sum of the shots for the whole period has been taken and the mean percentage number calculated for each month:—

Line Fishing (1904—1916).
Seasonal Variation in the Intensity of Fishing.

Method of Fishing	Monthly Percentages												Total Shots 1904—1916
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Great Line	20.9	26.9	16.1	1.1	4.4	4.6	1.0	1.7	1.6	2.3	8.0	11.3	4637
Small Lines ...	10.3	9.3	7.0	5.6	6.0	6.0	6.7	7.7	9.5	11.7	10.1	10.1	367444
Hand Lines ...	6.5	5.8	8.0	11.7	13.0	10.9	10.7	10.2	7.2	5.8	5.2	5.0	91753

Great Lines.

The great line fishing was prosecuted most intensively during the five months November to March; over 83 per cent. of the landings were made at that season. January and February were, however, the best months. During the summer months, and especially during the summer herring fishing season, the average number of landings was very low. The data are too meagre to treat the separate districts in detail but it may be noted that in the latter half of the period under review, the great line fishing was prosecuted chiefly in the last quarter of the year and was confined mainly to the Wick and Helmsdale districts. The greatest falling off took place in the first four months of the year after the year 1907.

Number of Great Line Shots (January to April).

Year	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
No. of Shots.	566	303	597	582	233	283	118	46	47	127	93	17	2

The method of fishing by cod nets which was introduced into the Firth in 1906 had become firmly established by season 1909 as part of the normal routine

and there is no doubt but that many of the fishermen who went regularly to the great line fishing turned their attention to the newer method of fishing in the early months of the year.

Small Lines.

Small line fishing was carried on in the Moray Firth throughout the whole year. If the war years, in which the conditions were somewhat abnormal are omitted, the following are the percentages of shots made in each of the four quarters for the period 1904—1913 (incl.):—

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
30.0	17.0	21.3	31.7

Sixty-one per cent. of the landings were made in the six months October to March and thirty-nine per cent. in the remaining six months. These relations between the numbers of landings in the summer and in the winter months remain remarkably constant during the period 1904—1913. During the war years 1914, 1915 and 1916 there was a tendency towards an increase in the relative proportions of catches in the summer months. In 1915 and 1916 the percentage number of shots in the six summer months was 55 and 57 respectively. It is evident, however, from the statistics not only for the whole Firth but also for the separate districts that most intensive fishing by small lines took place during the four months October to January, that is, the number of landings was high at this time even although operations were very liable to interruption by adverse weather conditions. The slackest time of the year for this fishing coincided with the period of preparation for and prosecution of the great summer herring fishing. With the return of the men from the herring fishing increasing activity was displayed at the small line fishing and it reached its height in October. There was a slight falling off during the following months due, in all probability, to the departure of some of the crews for the English herring fishing. The intensity of fishing, however, was well maintained from November until the month of February when the fishing began to ease off. The average number of shots landed in the month of April was only a little more than half the average number landed in January. The exact time at which the fishing began to ease off in the early months of the year varied; in some years it was earlier, in other years somewhat later than usual. These differences may have been due partly to the prevailing weather conditions, but as will be seen later they were also related to the seasonal offshore movement of the larger haddock just before the spawning period.

The seasonal intensity of the fishing in the different districts followed a course more or less similar to that for the whole Firth. The following are the percentages of shots for the four quarters of the year for each district during the period 1904—1913 inclusive:—

Small Lines — 1904—1913.

Percentage of Shots.

District	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total Shots
Banff	28.9	17.2	19.3	34.5	74387
Buckie	37.1	9.5	15.7	37.7	39963
Findhorn	25.5	21.1	24.9	28.5	67769
Cromarty	29.1	19.2	24.8	26.9	60552
Helmsdale	33.9	13.5	20.2	32.4	31919
Lybster	26.9	3.8	5.5	63.8	2331
Wick	25.9	8.7	18.4	46.9	3118

The fishing was as a rule most intensive in all districts from October to February. This feature was most marked in the two northern districts where, however, the total amount of fishing was comparatively small compared with other parts of the Firth. In all the other districts the landings were more nearly equal in number in the first and last quarters of the year.

Hand Lines.

Hand line fishing was also carried on throughout the whole year in the Moray Firth. In contrast to the small line fishing, however, it was prosecuted most actively in the summer months as may be gauged from the percentage number of shots in each quarter of the year.

Hand Lines — 1904—1913.

	1st Quarter	2nd Quarter	3rd Quarter	4th Qarter
Percentage of Shots 1904—13	21.9	35.4	26.8	15.8

Approximately 62 per cent. of the shots were landed from April to September, the second quarter being that of greatest activity. Just as in the case of the small lines, there was a tendency for the relative intensity of fishing to increase in the summer months during the war years. In 1915 and 1916 the percentage number of shots for the six months April to September was 74.8 and 71.0 respectively. During the period 1904—1913 (incl.), however, the most intensive fishing occurred either in April or May and only in 1910 was it as early as March, while in 1904 and 1905 the shots in June were slightly in excess of those in May. In other words there were differences from year to year in the time of maximum intensity. The intensity of fishing was, however, well maintained until August after which it began to fall off. Thus the seasonal intensity of fishing by hand lines had an inverse relationship to that by small lines. In all probability a number of the fishermen change over from one method of fishing to the other at the appropriate season.

While as a rule the fishing was carried on with greatest intensity in all parts of the Firth in the second quarter of the year, there were differences with regard

to the incidence of the fishing at other times of the year in the different districts. The following are the percentages of shots for the four quarters of the year for each district during the period 1904—1913 (incl.):—

Hand Lines — 1904—1913 (inclusive).

Percentage of Shots.

District	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total Shots
Buckie	14.7	35.4	43.4	6.5	15623
Cromarty	6.3	71.1	16.7	5.9	5006
Helmsdale	27.9	41.3	17.2	13.6	13112
Lybster	32.3	28.7	19.2	19.8	8331
Wick	23.2	29.8	24.4	22.6	31086

In the Wick district where hand line fishing was prosecuted with greatest vigour the intensity of fishing was well maintained throughout the whole year. The second quarter of the year was the best period chiefly owing to the increased numbers of landings in the months of April and May. The small amount of line fishing carried on mainly from October to February had apparently little effect on the hand line fishing and there appeared to be little slacking off during the summer herring fishing.

In the Lybster district most hand line fishing was done in the first two quarters of the year. The small number of hand line shots in the last quarter is probably accounted for by the fact that some of the fishermen turned to small line fishing. Practically no hand line fishing was done at Lybster in the third quarter of the year probably owing to the absence of some of the crews at the herring fishing.

At Helmsdale where both hand line and small line fishing find favour, the hand line crews were busiest in the second quarter of the year and the number of hand line shots exceeded that for small lines. The hand line fishing declined in the third and fourth quarters simultaneously with improvement in the small line fishing which was at its best in the fourth and first quarters. While a number of crews may readily change from hand line fishing to small line fishing the data suggest that other occupations engaged the attention of some of the men during the summer months.

At Cromarty hand line fishing was confined mainly to the second quarter of the year when the number of landings by small lines was at its lowest. Small lining was, however, by far the more important method of fishing, the number of shots even in the second quarter of the year being more than three times as numerous as the hand line shots.

At Buckie hand line fishing was mainly a summer occupation carried on with greatest intensity during the summer herring fishing season by the older men.

On the return of the younger men from the herring fishing it was to the small line fishing that many of them turned their attention.

Summary.

The different methods of line fishing were prosecuted more or less continuously but with seasonal variations in intensity, each method having its own characteristic seasonal variation.

The method of fishing with great lines in the Firth was being abandoned rapidly. In the earlier part of the period 1904—1916, however, it was prosecuted most intensively during the five months November to March but after the introduction of cod nets the great line fishermen turned their attention to the newer method of fishing in the early months of the year and therefore in the later part of the period the dwindling great line fishery was confined mainly to the late months of the year.

Small line fishing was the most important and although carried on throughout the whole year the most intensive fishing took place during the four months October to January.

On the other hand the hand line fishing which was relatively of much less importance than the small line fishing, was prosecuted most intensively from April to September during the slack period for the small line fishing and at the time when most of the men were engaged in the summer herring fishing.

The Fluctuations.

Great Lines.

The Species Caught. In the table on p. 95 the numbers of shots made and the total quantities of fish landed yearly by great line fishermen are given. The gross weight of fish landed during the thirteen years amounted to only 23,638 cwts. and as the total number of landings was 4627 the average per 100 landings is approximately 510 cwts.

Twelve species of fish were recorded in the great line catches, but a number of these such as haddock, tusk, turbot, catfish and hake may be regarded as accidental occurrences in the shots from the Moray Firth. The following table shows, however, that the average quantities caught per shot and the composition of the shots landed in the different districts varied greatly.

From the table it will be seen that the average catch of cod was greatest in the Buckie and Findhorn shots, least in the Banff and Cromarty shots. Conger Eel, on the other hand, yielded the largest average per shot at Banff and Helmsdale. The lack of definite information as to the actual fishing grounds precludes comparison of the somewhat meagre statistics month by month for the separate districts.

Great Lines Average Catch per 100 shots 1904—1916 (incl.).

District:	Cod	Ling	Saithe	Haddock	Conger Eel	Halibut	Skate	All Fish
Banff.....	124	125	59	—	92	38	109	557
Buckie.....	663	65	30	4	24	38	83	916
Findhorn	537	63	2	—	17	19	123	765
Cromarty	159	133	—	—	—	—	—	302
Helmsdale	406	10	—	—	98	9	18	542
Lybster.....	396	—	—	22	66	9	5	505
Wick.....	276	21	26	4	20	27	62	442

Cod.

The characteristic fish of the great line shots was the cod; on the average it constituted over 65 per cent. by weight of the catches and only in the years 1914, 1915 and 1916 did the percentage contribution fall below 50. If the year 1916, when the number of landings was extremely small, be left out of consideration, the percentages are found to vary between 47 and 83. An examination of the data shows a great falling off in the total quantities of cod landed yearly and a slight but temporary increase occurring in the year 1912. The following are the relevant data:—

Cod.

Great Lines: 1904—1916 (incl.).

Average Catches in ctws. per 100 landings.

Year	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	Mean
Average..	294	227	**535**	**448**	336	210	206	257	**434**	338	203	221	**570**	335

The years 1906, 1907, 1912 and 1916 produced markedly good average catches of cod for the great line fishermen. Although the statistics are very meagre the combined data suggest that the general decline in the yearly landings by great lines was not due to any obvious decline in the abundance of cod in the Firth.

Seasonal Occurrence. It is sufficiently clear from Table IV (p. 148) that the cod species was caught by great lines in greatest numbers in the Firth during the period from November to April and that while fishing slacked off in the summer months cod were less numerous at that time. The mean catch per 100 shots remained almost steady during the months December to March but there was a rapid falling off thereafter, poor catches being obtained in the months of June, July and August.

The distinction in the statistics between the categories cod and codling may not always be clearly cut but there was a suggestion that codling were most numerous in the fourth quarter of the year, while cod were most numerous in the first quarter. This is shown by the following figures:—

Great Lines.

Mean Catch in cwts. per 100 shots.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Cod	243	194	30	236
Codling	144	21	40	189

In view of the fact that there are these seasonal variations, the fluctuations in the Firth from year to year can be ascertained only by comparing the mean catches for similar periods of the year. Unfortunately the data are inadequate for this purpose. For the first seven years, however, average weights in cwts. of cod caught per 100 shots in the first four months of the year have been calculated.

Great Lines. — Cod and Codling.

Average Weight per 100 shots (Jan. to Apr.).

	1904	1905	1906	1907	1908	1909	1910
Cod	141	243	451	367	191	78	143
Codling	175	71	92	129	184	166	41
Total	316	314	543	496	375	244	184

Thus shots were best in the early months in the years 1906 and 1907 when the catches consisted mainly of large cod.

Haddock.

One of the most important facts concerning the composition of the great line shots is the comparative absence of haddock from the returns. For the thirteen years under consideration only 170 cwts. in all were taken. The species contributed nothing to the total weight in seven of the years and only in 1910 and 1915 was the species sufficiently well represented in some of the catches to be worthy of notice.

Other Species.

The data are not sufficiently representative to deal with the other species in detail. Great line fishing in the Moray Firth was obviously a fishery for cod and no doubt the fishermen shot their lines mainly on those grounds where cod were expected to be found, the other species therefore occurring more or less sporadically in the catches. It would appear, however, that conger eel was most abundant in the months July to October, while such species as ling, saithe and halibut were taken most readily in the earlier months of the year. The erratic appearance of these species in the catches of the different districts in the different years suggests that the variations are due in a great measure to the actual grounds fished.

Whiting, plaice and flounders are not represented in the great line catches.

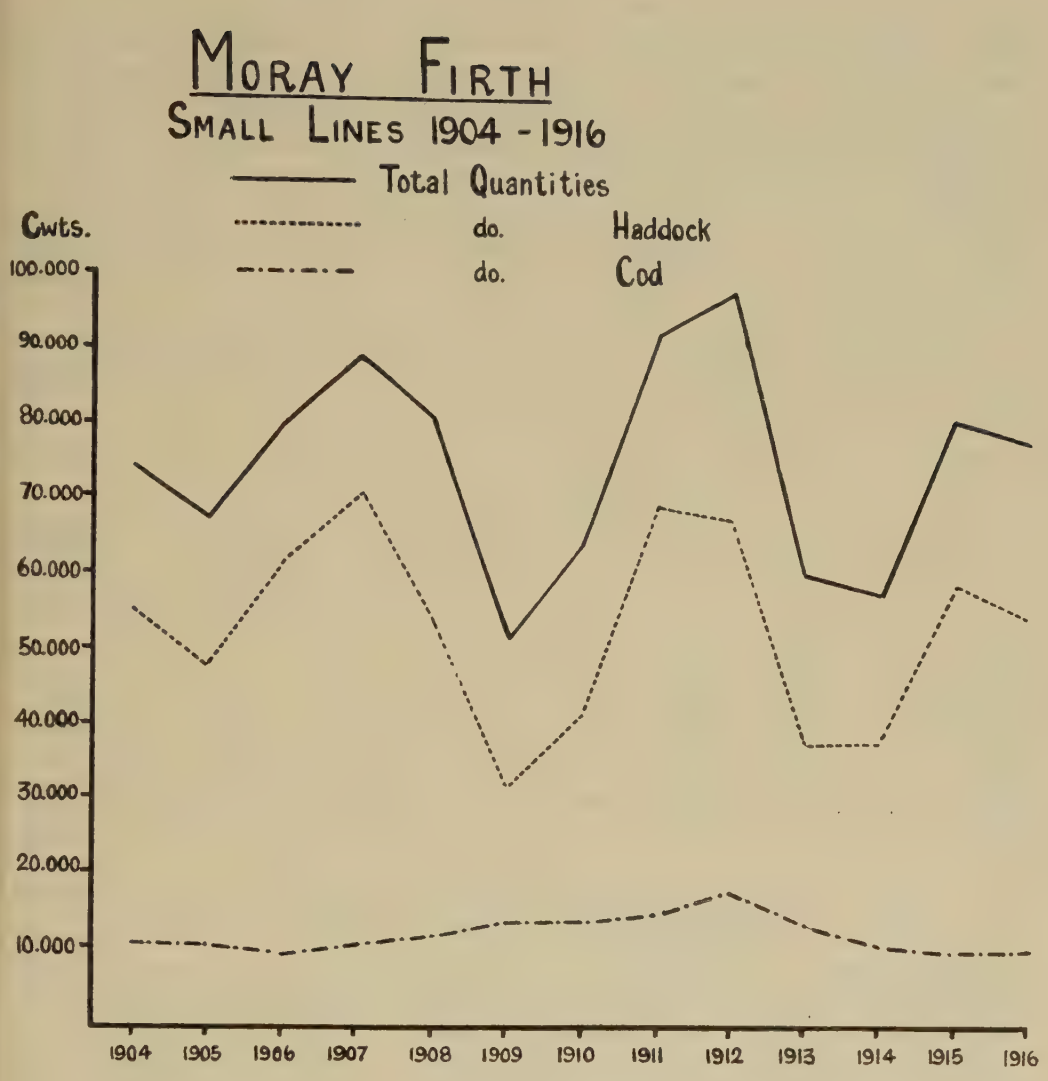


Fig. 4.

Small Lines.

The Species Caught. Although cod, whiting and plaice together contribute nearly one-third of the weight of fish caught by small lines the fishery is in reality one which depends for its success on the abundance of the haddock species (see Table II p. 147 and fig. 4). The average percentage contribution of haddock to the catches was 70 and while there were marked differences from year to year the contribution in no year fell below 60 per cent. of the gross weight of fish landed by this method of fishing. The three species (haddock, cod and whiting) taken

together made up over 90 per cent. of the total catch by weight and the proportional contribution by plaice varied between 2.5 and 7.5 per cent. of the gross total.

The small line fishing is usually prosecuted within a shorter radius of the home port than the great line fishing, the catches being landed daily. It must not be forgotten, however, that the small line boats may change their exact locus of fishing from time to time and indeed may seek more distant grounds, especially at times when fish are scarce in local waters. The statistics for each district will, however, give some indication of the scarity or abundance of the fish on the grounds most regularly fished.

The following table gives the average catch in cwts. per 100 shots of the principal species and the percentage contribution of each species to the total catch landed in the various districts.

Small Lines 1904—1916 (incl.).
Average Catch in cwts. per 100 shots.

District:	Haddock	%	Cod	%	Whiting	%	Plaice and Flounder	%	Total Weight in cwts. per 100 shots
Banff	196	68.98	41	14.66	45	15.76	—	0.29	284
Buckie	240	79.85	54	18.11	3	0.92	2	0.84	300
Findhorn	167	73.85	14	6.19	17	7.53	26	11.78	226
Cromarty	149	65.57	43	19.15	4	1.81	28	12.53	227
Helmsdale	199	65.57	57	18.69	12	3.98	36	11.74	304
Lybster	290	55.76	220	42.37	8	1.54	1	0.23	520
Wick	77	43.84	72	41.17	1	0.76	15	8.20	170
Moray Firth	186	70.23	41	15.41	19	7.27	17	6.6	264

In the two most northern districts, Wick and Lybster, cod was almost as important as haddock. As a rule, however, the cod rarely constituted as much as 20 per cent. of the weight of the small line catches. As a matter of fact in the Findhorn district the cod was of very little importance to the small line fishers, the quantity caught being not much more than 6 per cent. of the total weight.

Flatfish were best represented in the landings at Findhorn, Cromarty and Helmsdale where they made up approximately 12 per cent. of the total weight of fish caught. In the Wick district too, eight per cent. of the total weight of fish caught by small lines was ascribed to flatfish. In the other three districts, however, the catches of these species were negligible.

It should be observed that in the above table the means for each district and species are calculated from the statistics for the whole period and that so far no attention has been paid to the loci of fishing and the seasonal incidence of the fishing. The influence of these factors, however, is evident from the varying character of the catches in the different districts. Plaice and flounders are most abundant in such sandy bays as Burghead Bay, Dornoch Firth, Sinclair Bay etc. which

are fished most intensively by the boats from the neighbouring creeks and the extent of the fishery is reflected in the district statistics. Indeed, the fishing for flatfish by means of lines in these sandy bays may almost be considered as a special form of small line fishing. It is carried on chiefly in the early months of the year, lug worm being used for bait and the catches consist almost exclusively of flatfish. The inclusion of these special shots with the small line catches of these districts therefore tends to lower the calculated average catch per shot of the other species.

The differences in the mean catches of haddock and cod in the Wick and Lybster districts are very striking. At Lybster the mean catch for haddock and cod was the highest for any district in the Firth; at Wick the mean catch for haddock was lowest, while for cod it fell very far short of the average catch at Lybster. In both districts the absolute amount of small line fishing carried on was very small and the difference may be due partially to the fact that the Wick totals include the special small line fishing for plaice carried on in Sinclair Bay. At Lybster there was no small lining for plaice and almost 64 per cent. of the small line fishing for haddock and cod took place in the fourth quarter of the year, that is at the time when the average catches of these species are high.

Haddock.

As has already been seen (vide p. 106) the small line fishing at Banff was carried on with much greater regularity throughout the year than at Buckie. During the summer six months when the general average catches of haddock were low, the Banff boats made approximately 37.5 per cent. of their total shots for the year, the corresponding figure for Buckie being 25. This difference in the incidence

Yearly Variation in the Catches.
Moray Firth 1904—1916. Small Lines.
Average Catches of Haddock in cwts. per 100 shots.

Year	Banff	Buckie	Findhorn	Cromarty	Helmsdale	Lybster	Wick	All Districts
1904.....	172	265	124	128	168	250	35	168
1905.....	174	225	103	125	165	222	135	150
1906.....	252	283	173	155	179	293	160	205
1907.....	283	254	208	177	225	391	41	233
1908.....	199	293	183	125	171	284	28	184
1909.....	154	296	125	106	113	178	2	142
1910.....	189	248	161	140	155	288	89	174
1911.....	257	264	232	181	221	416	63	230
1912.....	230	261	209	173	240	351	80	221
1913.....	177	250	124	143	191	338	22	171
1914.....	114	208	136	137	199	322	90	148
1915.....	180	138	201	180	252	276	134	190
1916.....	168	126	164	166	245	174	145	173
1904—16...	196	240	167	149	199	290	77	186

of fishing not only helps to account for the higher average catches of haddock and cod at Buckie but also helps to explain the high average catch of whiting in the Banff shots.

The data in the above table provide a measure of the degree of success with which haddock fishing was carried on from year to year by means of small lines during the period 1904—1916 (incl.). It will be noted that the average weight of haddock landed per 100 shots varied greatly not only from district to district but from year to year in each district. The district differences are due partly to the fact that the haddock are not distributed uniformly throughout the Firth and partly to the fact that each district has its own characteristic method of prosecuting the small line fishing both with respect to the selection of the fishing grounds and to the incidence of fishing throughout the year. On the other hand, the annual fluctuations are due in large measure to the changes in the distribution and absolute abundance and (or) the composition of the haddock stock in the Firth from year to year.

The mean catch of haddock per 100 shots for the Firth for the whole period was 186 cwts. The most unproductive years for the haddock fishing were 1909 and 1914 when the average catch per 100 shots fell as low as 142 and 148 cwts. respectively and the best years were 1907 and 1911 when the respective averages rose to 233 and 230 cwts. In fact there were four very good productive haddock years — 1906 and 1907 and 1911 and 1912 — for the small line fishermen and these occurring in pairs divide the period into alternating poor and good phases with respect to average catches.

While the fishermen of the different districts were not equally successful in the haddock fishing the good and bad phases in any one district synchronised more or less closely with the good and bad phases in the others. The amount of small line fishing carried on at Wick being insignificant the data for this district are left out of consideration. In all the other districts, with the exception of Buckie, there was a great similarity in the course of the fluctuations throughout the period. In general, good average catches were obtained in each district in the years 1906, 1907 and 1911, 1912, while in the other years the average catches fell to their lowest in 1909. The data for the Buckie district are, however, extremely interesting. It is a district in which the mean catch for the whole period was high. In the years prior to 1914 the fluctuations in the average catch per 100 shots were relatively small and the two periods 1906, 1907 and 1911, 1912 are not outstanding as in the cases of the other districts. Indeed in the year 1909 when extremely poor average shots were obtained in all other districts the landings at Buckie reached their highest average per shot. The small line fishermen of the Buckie district had apparently been able to secure good average catches in years when the fishermen of other districts of the Firth met with much less success. During the years 1908 and 1909 when the average catches per 100 shots were highest at Buckie, the catches

landed in the neighbouring districts of Banff and Findhorn were low. It is therefore probable that the greater success of the Buckie boats is to be ascribed either to the fact that they fished more energetically during the most productive period of the year or that, possessing larger boats, they had greater mobility and sought out more distant grounds where haddock were more abundant. It is obvious from the variations in the average catches that even for such a restricted area as the Moray Firth the calculated average yearly catches may not give an exact representation of the fluctuations in abundance of the haddock stock within the area from year to year.

Seasonal Variations in the Abundance of Haddock. The calculated mean monthly catches of haddock by small lines in cwts. per 100 shots for the whole Firth during the period 1904—1916 (incl.) are as follows:—

Haddock. — Small Lines 1904—1916 (incl.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average Catch in cwts. per 100 Shots	248	199	150	117	132	147	150	154	183	201	218	224

The sequence of events was practically the same in every year although the absolute abundance and the exact times of maximal and minimal catches varied from year to year. As a general rule the heaviest catches were obtained in December or January. About the end of January, however, a rapid falling off took place and in April the average catch per 100 shots was only half that of January. The smallest catches were made either during April or the beginning of May. The average weight of the catches then slowly improved throughout the summer months until about the end of August or beginning of September when the improvement became much more rapid. During the months October to January the average catch per 100 shots remained practically stationary.

Thus during the summer months the grounds frequented by the small line fishermen are relatively poor in haddock. At the end of the summer there is an immigration of haddock from beyond the precincts of the Firth and most of these fish remain in the area for most of the winter, only departing along with those which have reached maturity for the first time on the advent of the spawning season. In other words there is a summer-autumn migration for feeding and a winter-spring emigration for spawning and this phenomenon is repeated yearly with the greatest regularity.

The relatively slow improvement in the average weight of the catches during the summer months is due in all probability to the growth of the stationary population. The influence of the wave of immigrants which begins to be felt about September does not pass off until the following spring.

In the following table there is given the average catches in cwts. per 100 shots landed in the principal districts during the four quarters of the year.

Small Lines. — Haddock.

Average Catch in cwts. per 100 shots 1904—1916.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Banff	229	154	157	215
Buckie	323	122	162	241
Findhorn	164	135	158	191
Cromarty	139	111	154	185
Helmsdale	179	117	171	269
Lybster	293	217	341	297

The amount of small line fishing carried on at Wick was too small and irregular to be taken into consideration. The detailed data for the other districts show, however, that this inward feeding movement of the shoals and offshore spawning migration is a phenomenon which affects all parts of the Firth. Its magnitude and the distribution of the shoals within the Firth varies from year to year.

It will be noted that there are considerable differences in the average catches per 100 shots landed in the different districts in each of the four quarters of the year. Now, as small line fishing is carried on, as a general rule, within a short radius of the port of landing, these calculated average catches may be presumed to represent more or less faithfully the variations in the abundance of haddock in different parts of the Firth. But in some districts and especially at certain times of the year the main objective of the small line fishing is the capture of flatfish and not haddock and again in other districts at certain times of the year the fishermen may go much further afield in search of haddock than the usual fishing grounds in proximity to the port of landing. These influences are apparent in the composition of the catches of the various districts. Take for example the district of Helmsdale which includes the ports of Embo and Golspie in the Dornoch Firth. The small line fishing from these two ports is carried on almost exclusively within the limits of the Dornoch Firth and statistics are available for a long period of years as to the numbers of shots landed monthly, the composition of the catches and the total weight of each species caught. The following table gives the mean monthly catches of flatfish and haddock calculated from the combined data of landings at Embo and Golspie from 1895—1916.

Mean Monthly Catches 1895—1916 (incl.).

In cwts. per 100 shots. — Embo and Golspie.

Mean No. of Shots	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
per Month	116	163	131	87	92	94	113	117	160	160	159	159
Flatfish	47	179	155	128	61	25	46	62	47	27	6	2
Haddock	191	21	13	46	123	181	163	172	189	212	274	269

It is obvious from the table and from the accompanying diagram (fig. 5) that while intensive fishing by small lines was kept up during the first three months of the year there was a sudden fall in the catches of haddock in February and that for three months — February, March and April — the average catches remained very poor. There was, however, an almost equally sudden jump in the average catch of flatfish. In the months of November and December practically no flatfish were obtained on the lines, but in the month of February the largest catches of any month in the year were obtained and comparatively high average catches were maintained until April. In other words the flatfish replaced the haddock in the small line catches during the months of February, March and April because the fishermen set their lines baited with lug with a view to capturing the flatfish in the Bay. The calculated mean monthly catches of haddock taken by small lines during these early months of the year therefore do not provide a representative picture of the relative abundance of the species in this locality.

During the months of November and December, however, practically no fishing for flatfish was carried on from the ports of Embo and Golspie. The main object of the fishery by small lines in these months was the capture of haddock. The calculated mean catches of haddock in November and December at Embo and Golspie may therefore be compared with those made from other and more northerly ports in the district and with the Lybster district which is still further north and where no flatfish are caught by this method.

Small Lines. — Helmsdale District 1904—1916.

Average Catch in cwts. per 100 shots for November—December.

	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
Embo and Golspie ..	122	182	344	254	202	100	211	233	319	166	375	389	408
Helmsdale District (excluding Embo and Golspie)	211	213	419	326	264	272	249	496	385	220	231	268	307
Lybster District.....	328	282	293	358	272	188	347	592	302	396	363	214	200

The high average catches during these two months were due largely to the immigrants. The trend of the fluctuations on all three sections of the coast is strikingly similar. In each case 1909 and 1913 were poor years, while the catches in 1906, 1907 and 1911, 1912 were generally good. The immigrant shoals distribute themselves all along the coast apparently with a preference for the section between Helmsdale and Lybster although this is not an invariable rule. In some years, e. g. 1914 to 1916, very dense shoals penetrated as far as the Dornoch Firth.

Small line fishing for flatfish in the Cromarty and Findhorn districts was also at its best in the months of February, March and April. The change over by the fishermen from haddock fishing does not appear to have been so complete as

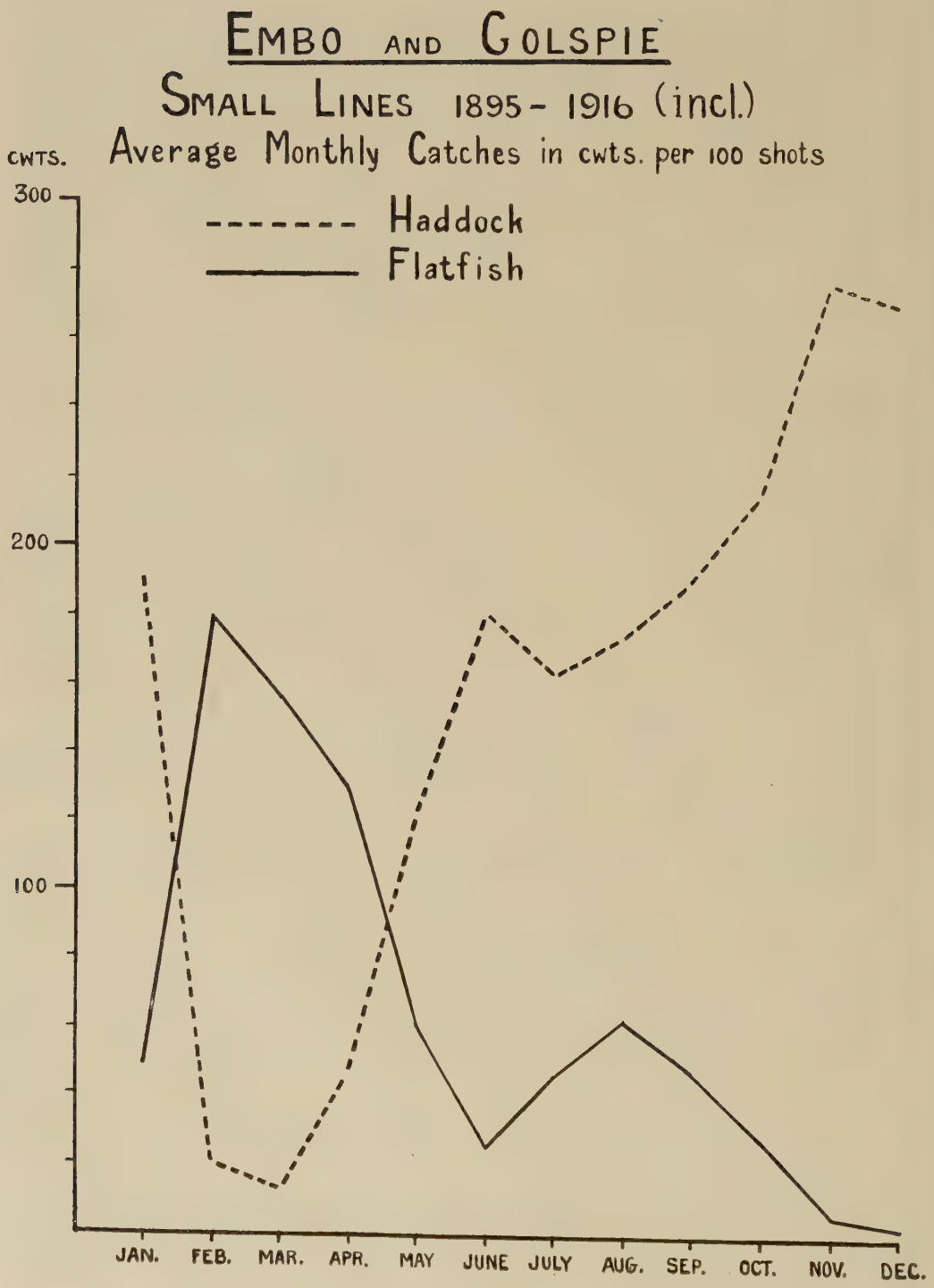

EMBO AND GOLSPIE
SMALL LINES 1895 - 1916 (incl.)
CWTS. Average Monthly Catches in cwts. per 100 shots
300
200
100
Haddock
Flatfish
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.

Fig. 5.

at Embo and Golspie and as no distinction was made in the statistics between the two kinds of fishing they cannot be separated by simple inspection of the data. In view of the fact that the fishery for flatfish was carried on with some degree of intensity in the two districts during the three months the relative abundance of haddock in that region of the Firth was greater than as represented by the calculated averages in the table on page 116.

Small line fishing for flatfish was of little account in the Buckie district and may be neglected. Indeed if the figures for Buckie be compared with those of the adjacent districts of Banff and Findhorn it will be seen that the average catches of haddock at Buckie were low during the second quarter of the year and exceptionally high during the first quarter. In all probability the small line fishing at Buckie during the second quarter of the year was confined to the smaller boats operating in the neighbourhood of the coast, the larger boats preparing for and departing to the summer herring fishing. During the herring fishing season there was a great similarity between the average catches in all districts except Lybster. At the close of the English herring fishing many of the men neither participating in the cod-net fishing nor proceeding to the West Coast herring fishing but turning their attention to the small line fishing crossed with larger boats from Buckie to the north-west shore and fished the more prolific grounds there, this resulting in a high average catch of haddock in the first quarter of the year.

While bearing in mind the variations in the methods of conducting the small line fishing from district to district, the data for the whole Firth may be used to obtain at least a broad view of the changes which have taken place in the supplies of haddock from year to year. As already stated the smallest catches were obtained in the months of April or May and the influence of the immigrant shoals on the catches beginning about September did not pass until the spring of the following year. It is therefore more appropriate that the "haddock year" should be considered as beginning in June and not with the calendar year. The average catches in cwts. per 100 shots have therefore been calculated for each month of each year and the following index figures obtained by summing the twelve months of each "haddock year" to illustrate the fluctuations in the relative abundance of the species in the Firth from year to year.

Haddock. Small Lines. Moray Firth 1904—1916.

Summation of Mean Monthly Catches in cwts. per 100 shots.

Year ended May	1905	1906	1907	1908	1909	1910
Index of Abundance	1710	1824	**2596**	**2437**	1855	1624
Year ended May	1911	1912	1913	1914	1915	1916
Index of Abundance	**2162**	**2734**	**2465**	1669	1666	**2312**

During the period reviewed three good phases alternated with three poor ones. Good average shots were obtained in the autumn-winter of 1906—1907 and 1907—1908; haddock were much less abundant in the Firth during the previous two years and in the succeeding two years; the average catches reached their lowest point throughout the whole period in the year ending May 1910. In the year ending May 1911 there was a decided improvement in the haddock fishery and this improvement lasted for three years, the middle year being best. Haddock were scarce in the Firth in the following two years but in the autumn-winter 1915—1916 the population was once more recruited by a larger wave of immigrants entering the Firth in search of food.

The Composition of the Catches. Four categories of haddock namely, extra large, large, medium and small are distinguished in the catches of the various districts. Unfortunately this classification was not adhered to consistently in the statistics and in some cases only the total weights of haddock landed are given. The following calculations are therefore based on the landings in which the categories were explicitly stated. As already mentioned, there are no fixed standards of lengths for these categories and as is well known, the connotation of the terms used varies from port to port and even at the same port from time to time. In the selections made of the fish caught, the amount of overlap in the sizes of haddock included in the different categories is influenced by such factors as the state of the market and the actual size and composition of the catches. In any keen selection, however, the tendency is to upgrade rather than to include any haddock in a lower category. The "smalls" may be considered as the most consistent group with a more or less definite upper limit — as a rule not exceeding 11 inches — and the weights of the catches therefore represent somewhat closely the varying abundance of "smalls" on the fishing grounds. The number of haddock classified as "extra large" is so small that they have been included with the "large". The average weight of fish per 100 shots in the three selections of large, medium, and small has been calculated for each month for the period 1904—1916.

Small Lines. Haddock — Categories Large, Medium and Small.

Mean Monthly Catches in cwts. per 100 shots 1904—16.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Large.....	82	76	59	42	31	27	25	32	40	52	59	67
Medium.....	101	89	66	63	63	73	80	87	93	100	107	117
Small.....	40	34	30	31	38	43	45	47	46	49	48	46

The average weights of the shots of small haddock fall during the first three months of the year and then begin to rise slowly in April to reach their highest

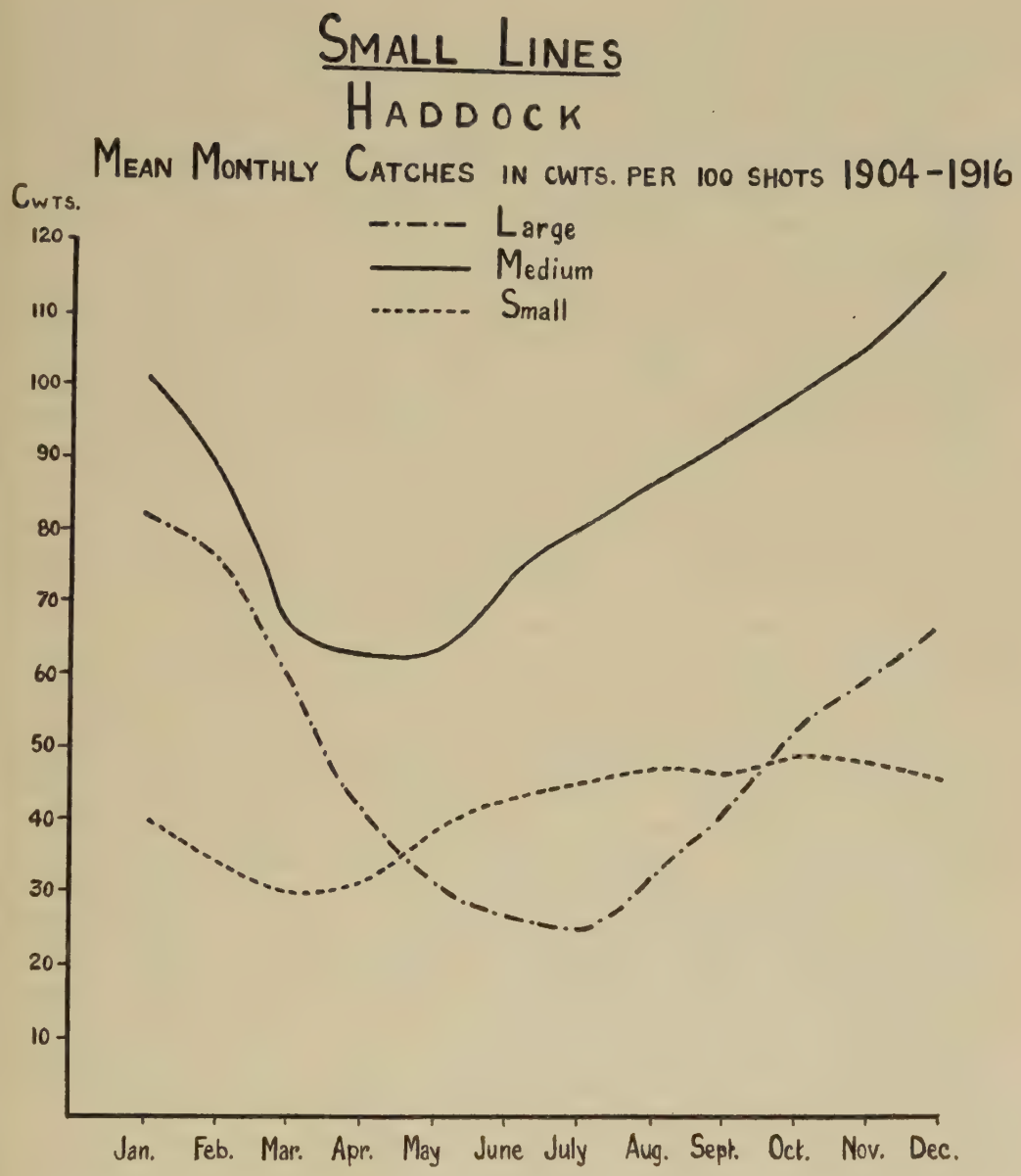


Fig. 6.

point about the month of October when the falling off begins to take place. There appears to be no doubt but that the "smalls" are a relatively stationary population and that, although the fall in weight during the early months of the year may be slightly exaggerated in the data for reasons already stated, there is a real reduction

of weight of these fish in the Firth at this time in all probability due both to the fishing and to offshore movement. The gradual increase in the average weights of the shots between April and October is probably to be ascribed partly to the growth of that part of the stationary population which had already reached marketable size at the end of the winter and partly to recruitment by the upgrowth of the smaller fish during the current summer. The rapid increase in weight of the small fish is able to counteract the loss through growth to the group of "mediums" and through the fishing.

Large fish are least numerous in the Firth in the summer months. While the number of these will be increased by the upgrowth of the "mediums", the rapidity with which the average weight of the catches of large haddock increases can be explained only by the assumption that there is an influx of shoals of large fish from areas beyond the limits of the Firth. The catches improve rapidly in average weight from August onwards and reach their highest in January — the "January haddocks" of the fishermen. The period during which these large catches of large fish are procured is of short duration for, although the numbers are reduced by the intensive fishing at this time, most of the mature fish pass out beyond the limits of the fishing areas of the small line boats to seek the spawning grounds. The numbers continue to fall even after the spawning period and the average weights of the catches do not begin to improve until the influence of the feeding migration begins to be felt.

"Mediums" are least numerous in the Firth in the month of April but the average weight per shot gradually improves thereafter both by the growth of the individuals which had reached "medium" size before winter and by the upgrowth of the "smalls" into the class. This group of rapidly growing fish mostly between two and three years old is joined by the smaller mature fish still classified as "mediums" which immigrate to the Firth along with the larger fish. There is thus a very rapid increase in the average weights of the catches which reach their best about the end of the year. Thereafter the adult "mediums" and the young fish which have joined the class and are maturing for the first time seek offshore to the spawning grounds. The numbers are still further reduced by the fishing and as no growth takes place during the first quarter of the year to compensate for such losses there is a rapid descent in the average weights of the catches which reach their lowest about the month of April or May.

The Annual Broods. Spawning is an annually recurring phenomenon which is limited to about three months in the early part of the year. The shoals of marketable fish are augmented by the growth of the successive yearly broods, each category being recruited in turn from the one below. Recruitment is therefore an annual event. The rate at which the group of marketable smalls is recruited depends on the duration of the spawning period and the speed of growth of the adolescents. Late spawned and slow growing adolescents take

much longer to reach marketable size than the early spawned and quick growing members of the brood. Owing to the great variation in the rates of growth of the different members of the same brood the times taken by the individuals of a brood to reach and pass through each successive category vary greatly. The number of recruits added to the marketable sizes by any brood depends on the intensity of spawning and the survival rate of the progeny. As most intensive spawning takes place beyond the limits of the Moray Firth the accession of adolescents to that area also depends, in great measure, on whether the conditions prevailing during and after the spawning season are favourable or unfavourable for the influx of these forms into the area.

The classification of the catches in the statistics does not permit of their separation into the progenies of successive broods and in view of the considerable overlap and variations in the limits of the sizes of the larger categories the data

Small Lines. — Haddock.

Monthly Average Catches in cwts. per 100 shots (smoothed). — 1904—1916. Medium, Large and Extra Large Categories combined.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1904 S.....	25	25	24	23	25	25	29	31	35	32	31	32
M. L. Ex. L.	209	280	150	117	93	92	93	103	114	135	137	149
1905 S.....	26	26	26	27	30	34	47	51	59	57	57	52
M. L. Ex. L.	157	140	101	79	66	69	68	78	93	111	122	132
1906 S.....	43	37	40	51	59	73	88	101	102	99	103	101
M. L. Ex. L.	143	137	113	88	83	85	95	106	126	148	170	197
1907 S.....	92	72	62	57	57	48	37	35	37	42	36	31
M. L. Ex. L.	191	166	118	92	95	127	145	168	192	222	238	251
1908 S.....	21	15	9	15	21	28	25	27	28	30	27	23
M. L. Ex. L.	232	188	119	102	106	123	131	140	148	158	166	174
1909 S.....	16	13	13	13	12	11	10	10	9	11	12	12
M. L. Ex. L.	163	139	103	78	77	84	92	103	113	138	157	178
1910 S.....	11	10	10	11	18	30	44	52	62	75	90	84
M. L. Ex. L.	176	157	119	94	78	80	80	94	108	128	139	160
1911 S.....	68	52	44	51	69	85	91	86	88	84	83	76
M. L. Ex. L.	170	162	123	105	92	106	107	131	148	177	196	224
1912 S.....	69	57	48	48	44	47	44	43	33	30	22	26
M. L. Ex. L.	120	185	124	116	117	120	131	153	174	205	220	239
1913 S.....	26	26	24	22	28	26	24	16	14	12	12	13
M. L. Ex. L.	251	222	174	117	96	86	81	91	103	109	134	192
1914 S.....	11	10	11	16	26	39	46	47	46	58	70	78
M. L. Ex. L.	211	190	124	89	69	60	60	59	69	81	99	109
1915 S.....	66	50	38	40	57	63	68	67	69	71	59	52
M. L. Ex. L.	118	117	99	84	78	89	96	107	149	180	200	175
1916 S.....	52	40	38	22	27	20	16	14	15	19	12	7
M. L. Ex. L.	151	138	129	134	134	143	149	156	161	169	171	178

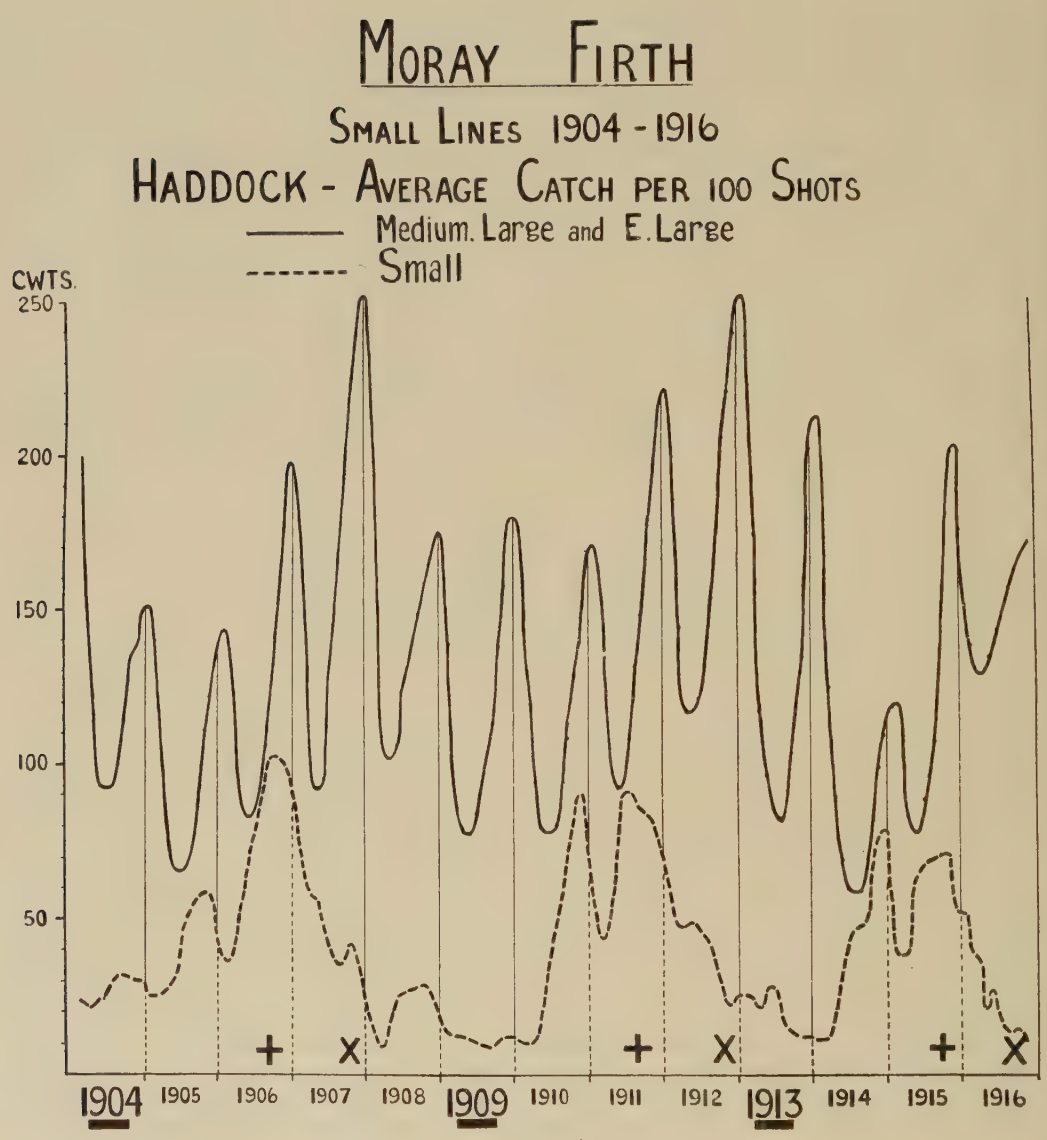


Fig. 7.

of the catches have been divided into two groups, the "smalls" being distinguished from the larger fish. The monthly average catches in cwts. per 100 shots for these two groups have been calculated and the figures smoothed in threes are given in the table on the previous page and represented graphically in the diagram (fig. 7).

The periodicity of the fluctuations of the average catches of the larger fish is striking. Every year about the month of August the catches of the larger fish

increased in average weight until they reached their maximum about December or January. Thereafter they rapidly declined and the smallest catches were obtained in the mid-summer months. This phenomenon was repeated without exception each year, the only essential difference from year to year being the height to which the wave of immigrants raised the average catches.

Although the marketable "smalls" are recruited each year by the upgrowth of the adolescents of previous years' broods this annual accession to the stock is not so clearly expressed in the statistics of the catches of the "smalls" as the yearly ebb and flow of the larger haddock into and out of the Firth is shown in the statistics of the other categories. In the period under review, however, it will be noted that there were three periods during which "smalls" were well represented in the catches and that these three good periods alternated with three very poor ones. Further, the favourable periods occurred in pairs of years in which the progress of events was very similar.

In the first year of each of these pairs the increase in the average weight of the catches did not become well marked until after the month of June, while in the second year the increase began much earlier in the season. In other words, the adolescents present in the Firth over winter began to grow in spring and as the summer advanced an increasing number of them reached marketable size. Towards the end of the season the rate of growth slowed down and during the winter months the weight of "smalls" in the Firth was reduced by fishing operations and probably by the departure of a few to the offshore grounds along with the spawning shoals. Most of the small fish had reached marketable size by their second winter and on the advent of more favourable conditions for growth in the following spring there was a rapid increase in their weight. Many of the quicker growers which had escaped capture through the winter soon passed into the category of the "mediums" and helped to augment the weight of that group but the rate of growth of the others and accessions from the succeeding brood were sufficient to make good any losses due to this cause and to the fishing operations, although the rate of increase gradually slowed down. During the third winter when growth had stopped there was a rapid decline in the catches of the "smalls" probably partly owing to the continuance of the fishing but mainly to the offshore movement of the group in company with the older mature fish. In the following spring the comparatively few fish of the brood which had remained through the winter as "smalls" rapidly passed into the category of mediums and as the "smalls" had not received many recruits by the upgrowth of succeeding broods there was a shortage of the group in the Firth throughout that year.

The effectiveness of a spawning season for the recruitment of the population of the Firth becomes apparent later in the commercial catches. Recruitment is, however, a gradual process owing to the variations in growth of the individuals of the same brood. The progeny of any spawning season begin to appear in the

catches of "smalls" in the second summer. These are the quick growers and it is not until the third summer that the influence of the brood on the catches of this category is most apparent. During the third summer some of the quick growers have entered the "medium" class but most of the progeny only reach this size in their fourth summer. The influence of this brood gradually wanes owing to reduction in numbers and the character of the catches are influenced in turn by each successive brood.

Thus in the period under review the survivors from spawning seasons 1904, 1909 and 1913 which entered the Moray Firth were comparatively numerous and consequently the catches of "smalls" were good in the two years succeeding (namely 1905 and 1906, 1910 and 1911 and 1914 and 1915). The progenies of these good brood years augmented the catches of the larger fish in 1906, 1911 and 1915 and still more so in the years immediately following. Thereafter the influence of these broods on the catches of large fish gradually waned and as they were succeeded by poor ones the catches in the intervening years gradually declined.

It is therefore clear that the main cause of the fluctuations of the average catches of haddock in the Moray Firth during the period 1904—1916 was the variation in the contribution made by the progeny of each successive brood to the population of the Firth. It will be noted that the successful brood years do not necessarily coincide with those years when the weights of the adult fish are greatest. The conditions prevailing after spawning have more influence on the future population of local grounds than the intensity of spawning.

Cod.

As the haddock fishery has been treated in some detail that of the cod which is relatively of much less importance to the small line fishermen is described briefly. During the period 1904—1916 (incl.) it contributed just over 15 per cent. of the total weight of small line fish caught in the Moray Firth. Only in the northern districts of Lybster and Wick where the amount of small line fishing is insignificant does the species rival the haddock in importance as a constituent of the catches.

The Distribution of Cod in the Moray Firth. Small line fishing is essentially a fishery for haddock and the fishing grounds are selected mainly for the capture of this species. The amount of cod captured by small lines is therefore dependent on the abundance of cod on the haddock fishing grounds and these may or may not coincide with the grounds in the Firth most frequented by the cod. In dealing with the statistics of the catches due regard must therefore be paid to the influence which such factors as the loci of fishing grounds and the incidence of the fishing throughout the year have on the calculated average catches of the various districts just as has been done in the case of the haddock.

The wide differences in the calculated average weights of the catches in the different districts (see table p. 112) suggest that the species is not uniformly distri-

buted. The calculated average catch per 100 shots in the Lybster district reaches the extraordinarily high value of 220 cwts. while it sinks as low as 14 cwts. in the Findhorn district. The most intensive fishing at Lybster occurred in the fourth quarter of the year and there is no doubt but that the average catch per 100 shots would have been lowered somewhat if fishing had been carried on steadily throughout the year. On the other hand, not only was the small line fishing carried on more consistently throughout the year in the Findhorn district but the small line shots for plaice in the early months of the year are included in the calculations. The ascertained value representing the relative abundance (weight) of cod on the Findhorn haddock fishing grounds is too low. Even if allowances be made for these influences it is obvious that the heaviest catches of cod were obtained in the Lybster area while the poorest catches came from the inner parts of the Firth. So too, the average values for Wick, Helmsdale and Cromarty districts are in all probability too low since the small line shots for flatfish are also included in the calculations. Small line fishing was carried on most regularly throughout the whole year from the Banff district but at Buckie the fourth and first quarters of the year were the most active periods and during these a number of catches were made by the larger boats on the more prolific grounds in the north-western area of the Firth. If all these disturbing factors are taken into consideration the following general statement may be made as to the distribution in the Firth of the class of cod caught by the small line boats. It should be noted that these comparable values relate to weight of fish and not to number of individuals. The best catches of cod are made by the small line boats along the north-west shore of the Firth. The most productive grounds are in the neighbourhood of Lybster, the average weight of the catches becoming poorer along the coast towards Cromarty. From Tarbet Ness to Kinnaird Head within the thirty fathom line the cod appear to be much more uniformly distributed but the average weight of the catches is much less than in the case of those from the north-western area. The poorest catches are obtained in the inner parts of the Firth on the Findhorn haddock grounds.

Seasonal Variations in the Abundance of Cod. Two categories of sizes are distinguished in the small line statistics, namely cod and codling. Owing to the distribution of sizes the fish caught in the Firth fall naturally into these two classes. As previously pointed out the actual numbers of individual fish between 20 and 30 inches are extremely small at all seasons of the year, especially when compared with the number of smaller fish. The great majority of the codling are under 18 inches in length. Though large cod are numerous only during the spawning season, the number of large fish (over 30 inches in length) caught by small line is extremely few at all times.

Unfortunately in some cases no distinction was made in the data between cod and codling. The monthly average catches in cwts. per 100 shots for cod and codling taken together have been calculated and the figures smoothed in threes are given in the following table and represented graphically in the diagram (fig. 8).

Small Lines. — Cod and Codling.

Monthly Average Catches in cwts. per 100 shots 1904—16 (incl.).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1904.....	57	53	44	37	25	17	13	12	15	21	27	32
1905.....	33	33	31	27	22	18	19	20	25	33	42	47
1906.....	45	47	40	33	22	18	15	14	16	23	29	34
1907.....	34	36	34	31	26	20	16	12	20	32	47	52
1908.....	56	55	49	37	22	12	8	12	19	31	47	58
1909.....	64	71	63	53	34	28	24	25	40	63	83	86
1910.....	71	59	50	52	42	31	20	32	51	73	73	76
1911.....	75	64	66	58	43	25	15	20	28	39	56	62
1912.....	66	67	71	65	45	30	20	25	39	58	78	86
1913.....	99	87	88	69	60	39	23	17	21	35	56	66
1914.....	64	49	42	38	32	22	18	23	32	42	51	50
1915.....	50	49	50	43	30	20	16	16	17	23	34	44
1916.....	50	53	49	43	31	23	13	10	15	25	42	52

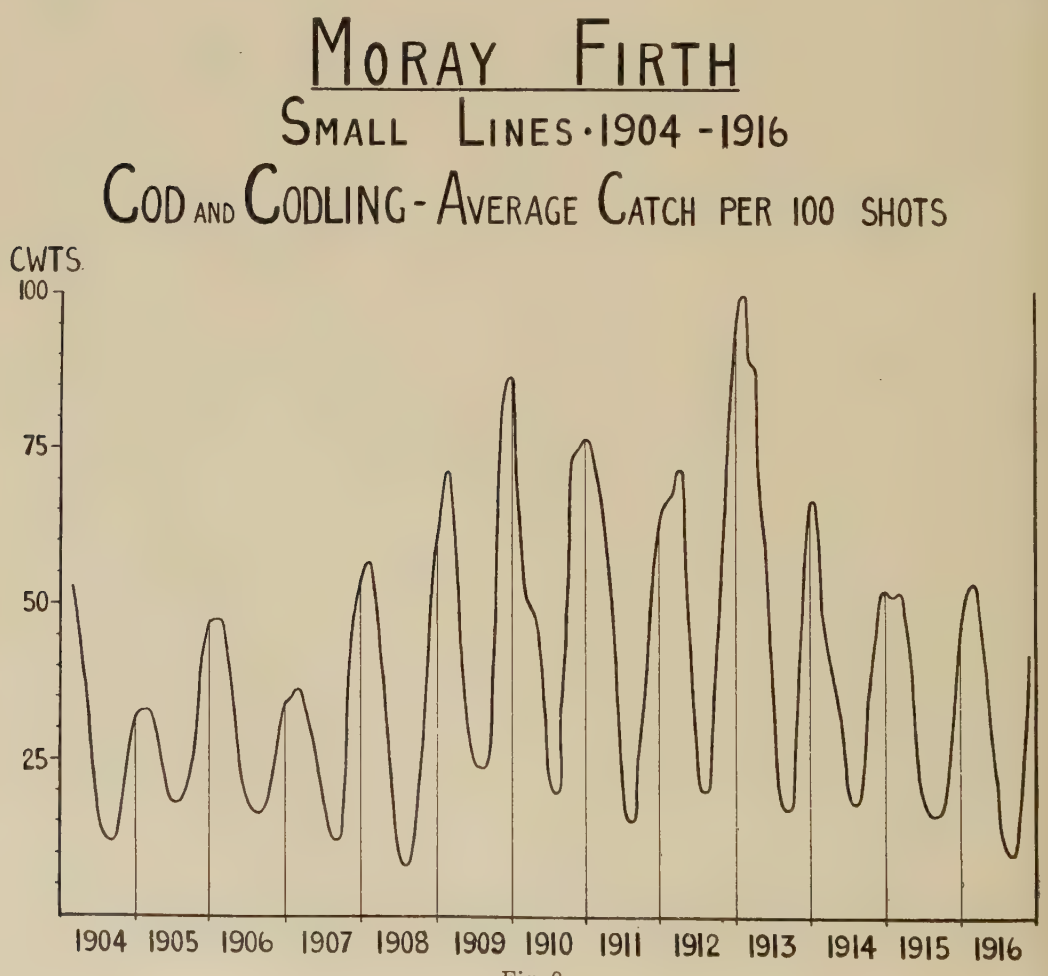


Fig. 8.

The periodicity in the fluctuations of the weight of the species caught by small lines is almost perfect. The same cycle of events takes place year after year. The average catches are smallest in the month of July or August, and they rapidly but steadily increase to reach their highest either in December or January to decline as rapidly and steadily to their lowest point in mid-summer of the following year.

If reference is made to the average monthly catches of haddock by small line (p. 115) it will be noted that the small line fishermen obtained the heaviest catches of both species in the winter months of the year. The haddock fishing fell away first, reaching its lowest point in April, whereas the great falling off in the cod and codling catches did not begin until the month of May. Similarly the haddock catches were the first to improve in the summer months.

In order to ascertain the influence of the presence of large cod on the small line catches the mean monthly catches of cod and codling have been calculated separately.

Cod and Codling.

Small Lines. — 1904—1916 (incl.).

Average Monthly Catches in cwts. per 100 shots

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Cod	5.2	5.5	4.7	1.8	0.8	0.6	0.4	0.3	0.4	0.4	1.0	2.0
Codling.....	49.5	48.6	50.3	43.8	33.0	20.3	14.5	14.4	24.9	36.8	48.1	62.4

Large cod were very poorly represented in the small line catches and only in the first quarter of the year were their numbers appreciable. There was a sudden falling off in the month of April and for the rest of the year their occurrence on the grounds fished by the small line fishermen may be considered as casual. There is no doubt but that these catches in the first quarter were augmented by large immigrant cod. These enter the Firth just before the spawning season and the survivors leave when the spawning act has been accomplished.

The case of the codling was very different. These are immature or young growing fish which increase rapidly in weight under congenial conditions. The best average catches were obtained in the last month of the year and these good catches were maintained during the first three months of the following year at a time when growth is practically suspended. A steady fall in the average weights of the catches set in, however, just at the beginning of the growth period of the year and the decline continued until July or August even although the growth of fish remaining on the haddock grounds at this period of the year must be rapid. The quick rise in the average catches after August suggests that the rapid fall in the average catches from April to July was not due to the fishing but to the departure of many of the fish from the precincts of the Firth and that the growth of the fish which remained was not sufficient at this time to compensate for the loss sustained through the fishing and through emigration.

It will be seen from the graph in Paper No. 5 drawn by Professor D'Arcy W. Thompson (Rapport et Proc. Verb., Vol. XIII, pp. 8 & 9) to represent the size frequencies of the species in the Firth during the first quarter of the year that the three year old fish are extremely few in comparison with the numbers just two years old. In other words there is a rapid diminution of the numbers of cod between the ages of two and three years, a diminution which is due mainly to their dispersal offshore and not to fishing operations. At the beginning of the growth period the loss of weight of fish in the Firth owing to the dispersal of these older fish is not counteracted by the upgrowth of the fish over one year old which move out from the coastal or seaweed zone and there is therefore a fall in the average weight of the catches. As the offshore movement of the fish over two years old tails off the growth of those remaining behind together with the vigorous growth of the fish between one and two years old is now sufficient to more than compensate for any losses due to fishing or emigration and the weight of fish in the Firth gradually increases. There is a corresponding rise in the average weight of the shots which reach their highest in the fourth quarter of the year.

Annual Fluctuations in the Catches. The following gives both the total weights and the average catches in cwts. per 100 shots of cod and codling captured by small lines during the period under review:—

Cod.

Small Lines 1904—1916 (incl.).

Year	1904	1905	1906	1907	1908	1909	1910
Total Weight landed	10304	9975	9170	9931	10971	12673	13595
Av. Catch in cwts. per 100 shots	31	31	30	33	38	57	58

Year	1911	1912	1913	1914	1915	1916	Total
Total Weight landed	13821	17479	13139	10073	8947	9540	149618
Av. Catch in cwts. per 100 shots	47	57	61	40	28	30	41

During the first three years the quantities landed yearly declined but thereafter and until 1912 the totals steadily increased, the landings again falling off in the last four years of the period.

The variations in the average catches show that although the species, though not so well represented in the small line catches as the haddock, had also favourable and unfavourable years for its occurrence in the Firth.

The average catch for the whole period was 41 cwts. per 100 shots and this was exceeded in each of the years 1909—1913 (incl.) while both in the years preceding and in those following the catches were below the average.

It may be noted here that in the small line fishery good haddock years are not necessarily good cod years. The poor haddock year of 1909 was a comparatively good cod year.

Large cod visit the Firth in numbers only for a short period every year at spawning time. An index of their abundance on the haddock grounds of the small line fishermen from year to year may therefore be obtained by summing the average catches per 100 shots for the first three months of the year:—

Large Cod.

Small Lines 1904—1916 (incl.).

Fluctuations in the Abundance in the 1st Quarter of the Year.

Year	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
Index of Abundance	26	21	28	16	16	10	6	11	5	22	5	2	0

Perhaps the actual quantities of large cod caught by small lines were too small to furnish sufficiently reliable information as to their relative abundance from year to year, but it would appear from the calculated data that in the years 1904 to 1906 and again in 1913 they were comparatively numerous on the haddock grounds in the first quarter of the year.

It has been shown that the market category "codling" includes in all probability at least three year classes of young quickly growing fish, but that most are between one and a half and two and a half years old. Fish of older year classes may be present but they are, as a rule, relatively few in number. The weight of the catches will depend on the relative numbers of the different year classes represented. Now it should be observed that any increment in the average length of the codling implies a proportionally much greater increment in the average weight and hence changes in growth rates from one year to another will affect the average weights of the catches. The abundance or scarcity of fish of older age groups will, however, have most influence on the average weight. Their frequency of occurrence may be due either to the fact that they are the progeny of a very successful year brood or that a number of them have remained behind in the Firth instead of moving offshore with the other members of their year class. In short, the average weight of the catches depends on the growth of at least three annual broods and on their relative and absolute numbers in the catches.

No distinction can be made in the statistics as to the relative numbers of each year class present in the catches and it would have been impossible to apportion by simple inspection the share contributed by each year class to the total weight. Extensive age-determinations would have been necessary.

In attempting to evaluate the fluctuations in the total weight of "codlings" in the Firth from year to year, it is more appropriate to consider the year to begin in August as this is more in accordance with the annual cycle of events and involves the inclusion of the smallest number of year classes in the calculations for each year.

The average catches in cwts. per 100 shots for each month of the "codling"

year have been summed and the following index figures obtained to represent the fluctuations in the relative weights of the species in the Moray Firth from year to year.

Codling.

Small Lines 1904—1916 (incl.).

Summation of Average Monthly Catches in cwts. per 100 shots for the year ended July.

Year ended July	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	Mean
Index of Abundance..	248	339	286	379	491	611	637	568	725	448	450	397	465

The mean figure for the whole period is 465 and hence from the year ending July 1909 to the year ending July 1913 may be considered as a group of good years for codling in which seasons ending July 1910, 1911 and 1913 were exceptionally productive. In all probability this succession of good "codling" years was due to a succession of favourable spawning seasons in which large numbers of the baby cod became safely established in the coastal zone of the Firth. At least there does not appear to have been any exceptionally bad spawning season during this particular group of years. In view of the fact that the catches are composed mainly of fish from one and a half to two and a half years old it would appear that these good years for the brood extended from 1906 to 1911. It is unlikely that the high average catches for the year ending July 1913 were dependent mainly on the 1912 brood as there was a considerable decline in the average catches in the following year when the 1912 brood probably contributed its largest quota to the weights of the catches.

Whiting.

Very little comment is required regarding the occurrence of whiting in the small line catches. As may be seen from the table below it constituted less than 8 per cent. of the total weight of fish and only in the districts of Banff, Findhorn and Helmsdale was the species landed in sufficient numbers to be worthy of consideration. At Banff the average catch per 100 shots reached the very high value of 45 cwts. and the species made up almost 16 per cent. by weight of the fish landed in the district. In the Findhorn and Helmsdale districts the average catches per 100 shots were 17 and 12 cwts. respectively and represented approximately 8 and 4 per cent. of the weight of the district landings.

Seasonal Variations in the Abundance of Whiting. The calculated mean monthly catches of whiting by small lines in cwts. per 100 shots for the whole Firth during the period 1904—1916 (incl.) is as follows: —

Whiting. — Small Lines 1904—1916 (incl.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Average Catches in cwts. per 100 shots	8.3	7.4	7.0	6.8	10.9	31.9	49.2	43.8	27.2	19.4	14.0	12.7

The time of the year at which whiting reaches its maximum abundance (weight) in the Firth is quite distinct from that of either haddock or cod. The average catches were lowest in March or April and, gradually improving as the season advanced, reached their best in the summer months, June, July and August and then gradually became smaller to reach their lowest in the following spring. Hence the high average catches of whiting in the Banff district may be accounted for, at least partially, by the fact that the small line fishing is carried on there with considerable intensity in the third quarter of the year.

The unfailing regularity of the yearly rise and fall of the whiting catches is shown in the following table wherein are given the average monthly catches in cwts. per 100 shots for the period 1904—1916 (incl.) and is illustrated in the accompanying diagram (fig. 9).

Small Lines. — Whiting.

Average Monthly Catches in cwts. per 100 shots (smoothed) 1904—16 (incl.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1904.....	7	7	8	11	13	18	22	25	20	16	12	8
1905.....	6	6	9	15	31	39	36	22	15	14	14	15
1906.....	14	11	10	15	18	24	22	23	17	15	13	11
1907.....	8	6	4	6	9	14	18	19	17	18	19	16
1908.....	11	6	7	9	33	60	80	64	46	31	29	20
1909.....	13	9	9	9	10	11	14	18	16	13	8	6
1910.....	5	5	5	5	15	30	38	33	23	18	17	14
1911.....	12	9	8	6	10	15	19	17	14	13	12	10
1912.....	8	5	5	3	17	29	42	37	32	24	20	14
1913.....	12	8	7	8	15	21	33	36	35	22	13	8
1914.....	6	6	5	5	9	32	56	66	50	27	12	5
1915.....	5	6	5	4	7	34	59	64	43	20	12	5
1916.....	5	4	5	6	22	46	64	59	39	22	12	8

Each successive wave of whiting is assumed to have begun in May and the index figures, found by summing the average catches for the twelve months of the "whiting year", represent the fluctuations in the weight of whiting in the Firth from year to year.

Whiting. — Small Lines 1904—1916 (incl.)

Summation of Average Monthly Catches in cwts. per 100 shots for the year ended April.

Year ended April	1905	1906	1907	1908	1909	1910
Index of Abundance	170	236	167	163	403	116

Year ended April	1911	1912	1913	1914	1915	1916	Mean
Index of Abundance.....	223	131	250	205	277	244	215

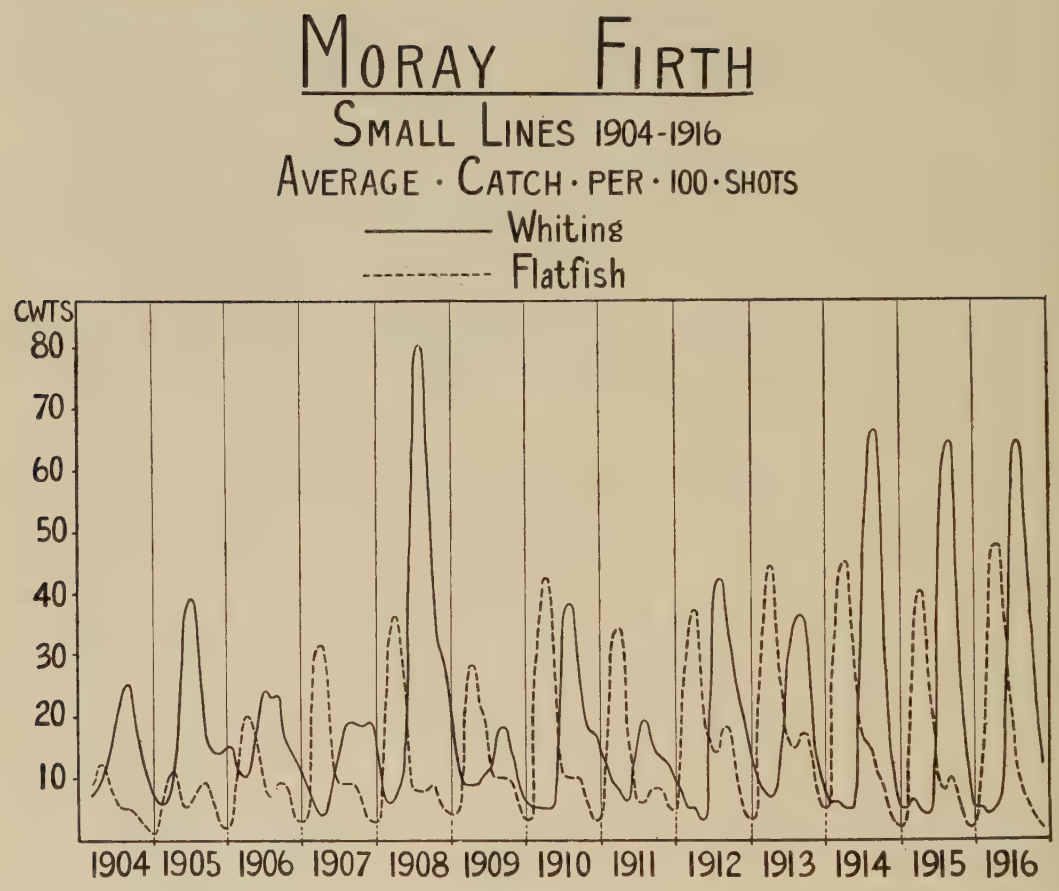


Fig. 9.

The outstanding year was that which ended in April 1909. It will be noted, however, that the weight of whiting in the preceding year was low and that in the succeeding year the index figure was the lowest for the whole period. While no distinction was made in the statistics between large and small whiting, the rapid rise and fall of the index figures suggests that the small line fishery for whiting was dependent for its success mainly on the abundance in the Firth of the progeny of a single year brood. Whiting spawn in the spring months and the progeny are too small at the end of the first or even second years of growth to be of market value. In all probability, therefore, the increase in the average weight of the catches in the summer months is to be ascribed to the growth of the fish in their third year. The outstanding catches of the year ended April 1909 appear therefore to be due to a successful brood year in 1906 while the poor catches of the following year was the result of an unsuccessful brood year in 1907.

The fall in the catches at the end of August before growth has ceased for the season suggests that many of the whiting begin to leave the Firth in their third year.

Flatfish.

It would serve no useful purpose to discuss at length the statistics of the flatfish. Fishing for flatfish was carried on in the sandy bays round the coast chiefly in the months of February, March and April with lug worm as bait. The areas principally fished were Dornoch Firth, Burghead Bay, and Nairn Bay, but a small amount of fishing was also carried on at Cromarty and in Sinclair Bay. The amount of fishing for plaice carried on in other bays was almost negligible.

Three species occurred in the catches, namely flounder (*Pleuronectes flesus*), plaice (*Pleuronectes platessa*) and common dab (*Pleuronectes limanda*). A clear distinction between these three species was not always made in the statistics and indeed in the Findhorn district in the earlier years of the period under review they were slumped together under the term "flounder". Plaice was the most important species both as regards value and total weight landed, while common dab appears to have been taken in such small quantities as to be almost negligible. The plaice were given in three categories, large, medium and small, but here again the distinction between the categories does not appear to have been rigidly adhered to. The statistics for the three species have been combined and the weights in cwts. per 100 shots ascertained for each month of the period under review. These values are recorded graphically in the diagram (fig. 9). The best months for the capture of flatfish were February, March and April. After April the weights of the catches landed fell off and reached their lowest in the last month of the year. During the summer-autumn months of July, August and September, however, slightly better catches were obtained. The fishing took the same course each year.

It has already been shown that in the spring months some of the small line fishermen turn from the haddock fishing even at a time when the species is abundant and fish almost exclusively for flatfish. Now no distinction was made in the statistics between the two types of small line fishing carried on and as some of the fishermen at certain creeks were engaged at haddock fishing while others had turned their attention to plaice fishing, the calculated average catches provide no index as to the abundance of the species within the area fished. At the two creeks of Embo and Golspie, however, practically all the fishermen appear to have turned to lug-bait fishing in the months of February and March during the period 1904—1916 (incl.) as the landings of haddock at these creeks became almost nil during these two months although the number of small line shots landed remained high. The statistics for these two creeks have therefore been combined and the following are the average monthly catches in cwts. per 100 shots for the whole period:—

Plaice.

Embo and Golspie. — Small Lines 1904—1916 (incl.).

Average Monthly Catches in cwts. per 100 shots.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Av. Catch in cwts. per 100 shots	48.2	152.9	148.4	141.9	64.9	16.9	47.8	60.4	40.7	20.2	5.3	—

There is the same sequence in the figures as was found for the whole Firth except that the rise in the summer-autumn months is more pronounced. These calculated averages can be taken only to represent the average weight of flatfish landed each month at these two creeks. They do not represent the varying abundance of flatfish in the Bay.

In view of the fact that the small line fishing was devoted almost exclusively to the capture of flatfish during the months of February and March, the statistics for these two months may be combined to ascertain the annual variation of the flatfish in the Bay at this season throughout the period.

The following table gives the average catches for February and March only:—

Plaice.

Embo and Golspie. — Small Lines 1904—1916 (incl.).

Average Catch in cwts. per 100 shots during the months of February and March.

Year	1904	1905	1906	1907	1908	1909	1910
Av. Catch in cwts. per 100 shots	124.0	115.9	165.8	165.3	194.3	94.8	127.4

Year	1911	1912	1913	1914	1915	1916	Mean
Av. Catch in cwts. per 100 shots	167.9	228.6	159.6	148.3	287.5	59.8	151.0

The amount of fishing in February and March 1916 was small and may therefore be left out of reckoning. The poorest spring for flatfish in the Bay appears to have been 1909. The mean catch for these two months for the whole period was 151 cwts. per 100 shots and this quantity was made up of 17.9 cwts. of large, 81.7 cwts. of medium and 51.4 cwts. of small fish. Thus most of the fish caught by small lines are probably immature fish. It will be seen from the table that there was considerable variation in the abundance of fish in the Bay from year to year and a more detailed examination shows that the relative proportions of the different categories constituting the catches also varied from year to year. Flatfish appear to have been very scarce during the spring of 1909 while in 1908, 1912 and especially 1915 they appear to have been very abundant. In season 1912 and 1915 small fish formed the most of the catches while from 1911 to 1914 no large fish were recorded as having been landed during these two months.

Hand Lines.

In a previous table (p. 95) there is given the share hand-line fishing contributed to the total catch of line fish taken from the Moray Firth and the statistics show that this method of fishing may be said to have just held its own during the period under review. It fluctuated in importance from year to year, but on the whole did not depart much from an average contribution of 15 per cent. by weight to the total catch of line fish.

Hand line fishing was not prosecuted with the same vigour in all parts of the Firth. The following table gives the total amount and the proportion of the hand line catches landed in the different districts:—

Hand Lines. — 1904—1916 (incl.).
District Contributions.

	Total Quantity in cwts.	Percentage Contribution
Banff	1780	1.01
Buckie	17573	9.96
Findhorn	Nil	Nil
Cromarty	9275	5.26
Helmsdale	38211	21.66
Lybster	23595	13.37
Wick	85993	48.74
Total...	176427	100.00

At Findhorn no fish were recorded as having been landed by this method of fishing and at Banff the fishery was negligible, making only 0.62 per cent. of the total. It was on the north-west shore of the Firth that hand line fishing was most favoured, the weight of fish landed at Wick being almost as much as the total weight landed at all other ports in the Firth.

Species Caught. The following are the percentage contributions to the catches by the various species:—

Cod	86.63 per cent.
Haddock	7.74 ,, ,,
Whiting	0.54 ,, ,,
Flatfish	0.58 ,, ,,
All Others	4.51 ,, ,,

According to the statistics there is a very significant change in the composition of the catches during the period under review although cod was always the mainstay of the fishery. There is a steady rise in the relative importance of this species in the catches; it advances from a contribution of 64 per cent. in 1904 to one of 94

per cent. in 1916 to the total weight of fish caught by hand lines. This advance is gained largely at the expense of the haddock which contributes 21 per cent. of the total catch in the first three years and less than one per cent. in each of the last three years. The falling off at the same time in the contributions of other species not specifically enumerated in the table is also suggestive. In the years preceding 1904 no distinction was made between small line and hand line shots and it is possible that in the early years of the special period some small line shots may have been included with the hand line shots.

Hand Lines. — 1904—1916 (incl.).
Average Catch in cwts. per 100 shots.

District	Cod	%	Haddock	%	Whiting	%	Flatfish	%	Total Weight in cwts. per 100 shots
Banff	14	17.42	0.9	1.07	1	1.46	0.3	0.39	80
Buckie	57	55.66	39.0	38.18	5	4.88	—	0.12	103
Findhorn	—	—	No fishing		—	—	—	—	—
Cromarty	129	86.29	5.0	3.33	—	0.02	14.1	9.17	149
Helmsdale	214	98.64	1.0	0.59	—	0.01	—	0.07	217
Lybster	206	95.38	1.0	0.62	—	—	—	—	216
Wick	198	86.71	16.0	7.27	0.2	0.07	0.3	0.17	228

The average catch per shot was greatest in the northern area. In the Banff district where hand line fishing was unimportant the high percentage of species not specifically mentioned was referable to the saithe. While cod was the most important species in the catches at Buckie, the haddock contributed over 38 per cent. by weight for the whole period. The cod, however, gradually became predominant in the catches at the expense of the haddock; in 1904 it constituted only 23 per cent. of the landings, while in 1913 the entire catch was composed of cod. At Cromarty much of the hand line fishing was carried on for flatfish although here also the largest share by weight was attributable to the cod. The annual contributions of cod ranged from 54.60 per cent. to 93.50 per cent., the mean for the period being 86.29 per cent. The share of the flatfish in the total weight varied within very wide limits. It amounted to only 2.98 per cent. in 1904, while in 1909 it reached as high as 28.19 per cent. Few comments need be made on the hand line fishing of the Helmsdale and Lybster districts. Cod was the species caught practically to the exclusion of all others and the average weights per 100 shots were extremely high. This was also the case at Wick especially in the later half of the period, when cod contributed over 90 per cent. of the total weight of the catches made by hand lines. Only in the first four years, namely 1904—1907, did haddock make up over 10 per cent. of the total weight of fish.

Cod and Haddock.

There are only the two species (namely cod and haddock) in the hand line catches which it is necessary to consider. It is of interest, however, to compare the catches of these two species made by small lines and hand lines.

Cod and Haddock.

Average Catches in cwts. per 100 shots by Small Lines and Hand Lines 1904—1916.

	Year.....	1904	1905	1906	1907	1908	1909	1910	1911
Haddock	Small Lines .	168	150	205	233	184	142	174	230
	Hand Lines .	44	28	36	15	11	5	4	1
Cod	Small Lines .	31	31	30	33	38	57	58	47
	Hand Lines .	98	95	102	159	161	117	300	300

	Year.....	1912	1913	1914	1915	1916	Average (1904—1916)
Haddock	Small Lines .	221	171	148	190	173	186
	Hand Lines .	6	6	2	1	1	15
Cod	Small Lines .	57	61	40	28	30	41
	Hand Lines .	290	194	182	152	198	166

While the line fishing in the Firth is dependent on the haddock and cod it is clear from the above table that the small line fishing is essentially a haddock fishery while the hand line fishing is almost exclusively a cod fishery. Now during the period under review there was practically no change in the manner in which the small line fishing was carried on. The bait used has remained the same throughout the period; there have been practically no changes in the sizes of hooks and strength of snoods used, factors which determine the maximum size of cod most readily taken by small lines. The data from one year to another are therefore more or less comparable and the average catches per 100 shots give some indication as to the varying abundance of fish on the ground. But as has already been stated there are two distinct forms of hand line fishing, the one with baited hook and the other by means of the "ripper". The "ripper" is used almost exclusively for cod. Although each of these methods has its favoured season both may be used on the same grounds at the same time. No distinction was made between the two methods in the catch statistics and it is obvious, therefore, that without more detailed data as to the actual method of hand line fishing employed, the calculated yearly averages per 100 shots must be treated with caution as representing the abundance or scarcity of cod within the area.

If the calculated yearly catches of haddock by small lines and hand lines are compared, it will be noted that the tendency for the haddock to disappear from the statistics of the hand line catches was not due to any progressive decline

in the abundance of haddock in the Moray Firth. The haddock continue to fall off in the hand line catches in the last half of the period even in the good years.

Cod. — Yearly Variations in the Catches.

Hand Lines. — 1904—1916 (incl.).

Average Catches of Cod in cwts. pr. 100 shots.

Year	Banff	Buckie	Cromarty	Helmsdale	Lybster	Wick	All Districts
1904	28	18	142	142	196	133	98
1905	8	18	100	154	166	150	95
1906	80	24	94	152	170	146	102
1907	112	99	136	207	261	144	159
1908	100	39	215	225	234	146	161
1909	—	77	93	119	165	124	117
1910	—	107	131	218	210	172	170
1911	—	139	136	389	307	269	300
1912	—	127	175	240	269	388	290
1913	—	113	89	110	180	277	194
1914	—	146	117	177	168	224	182
1915	—	105	95	188	154	207	152
1916	—	128	89	152	151	251	198
Total Average...	14	57	129	214	206	198	166

There were considerable fluctuations in the catches of cod by hand lines in the different districts within the period under review. It cannot be assumed, however, that transitions from one type of hand line fishing to another account for the rise and fall in the average catches throughout the whole period.

In the case of the combined statistics for all districts it would appear as if there had been two good periods and two bad periods, but again since the statistical data are lacking in the necessary detail it cannot be affirmed that the cod in the second period were twice as plentiful as in the first period. The trend of the figures, although not coinciding absolutely, are however all in the same direction whether the averages for the whole Moray Firth or those for the separate districts are taken. The years 1904 and 1905 as well as 1906 were poor years for the hand line fishing. This poor period was followed by a more prosperous one which included the years 1906 and 1908. In all districts except Wick, 1907 was a good year compared with the preceding and succeeding years. There followed a lean year in 1909 throughout the whole Firth with the exception of the Buckie district. Cod were again more plentiful in the catches in 1911 although at Wick and Cromarty it was not until 1912 that the highest point was reached. The cod then appear to have become less numerous; the average catches dropped rapidly and reached their lowest point about 1915.

The fluctuations were rapid but there was no indication of any progressive diminution in the stock of cod in the Firth.

Seasonal Variations in the Abundance of Cod. It is obvious from an examination of the data of the hand line catches that the distinction between cod and codling had not been consistently maintained throughout the period. It has therefore been necessary to combine these two categories, and owing to the great differences between the catches on the north-west shore and the south shore, the statistics for these are treated separately.

The catches of cod by hand lines on the north-west coast were heavier in all months of the year than those made on the south coast. If the data for the districts of Helmsdale, Lybster and Wick are treated separately, values of somewhat similar magnitude are obtained in all the months. The catches of these three northern districts where the hand line fishing was prosecuted with greatest intensity have therefore been combined and are compared with those of Buckie as representing the conditions on the south shore.

Cod and Codling. — Hand Lines 1904—1916 (incl.).
Average Monthly Catches in cwts. per 100 shots (smoothed).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Helmsdale Lybster... Wick.....	217	241	241	230	207	197	187	174	164	170	182	203
Buckie.....	131	117	115	99	75	38	25	25	55	93	133	139

There were very distinct differences with regard to the variations in the catches from month to month in the two regions of the Firth. On the north-west coast the catches maintained a high average value throughout the whole year. The best catches in this area were obtained in the first and second quarters of the year. The decline in the catches which was a very gradual one began in April and reached its lowest in September.

On the other hand there was a very marked difference between the summer and winter catches on the south coast. The catches reached their lowest in the months of June, July and August, thus almost two months earlier than those in the northern district. The same sequence of events are observable in these two districts in every year.

It will be noted in the table (p. 140) showing the yearly variations in the catches of the various districts, that the average catches at Buckie improved enormously after 1909. Even in the years 1910—1916 (incl.) the average catches were much below those of the north-west shore and the differences between summer and winter catches were likewise well marked. In the absence of definite information as to the character of the fishing carried on in these two localities, the data suggest that cod were either more numerous on the northern grounds or that the fish caught were larger than those of the south shore. The low average catches in the Buckie district during the summer months may, however, be due in part to the fact that

smaller boats with fewer men were employed at hand line fishing at this period of the year. No specific information is available, however, regarding this aspect of the matter. There is, however, a remarkable likeness between the trend of the average catches of codling for hand lines and those for small lines. This resemblance is brought out by reducing the average monthly catches per 100 shots to percentages.

Cod and Codling.

Average Monthly Catches in cwts. per 100 shots expressed as percentages of the total for the year.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Hand Lines	12.5	11.2	11.0	9.5	7.1	3.6	2.4	2.4	5.2	8.9	12.7	13.3
Small Lines	11.1	10.9	11.3	9.9	7.4	4.6	3.2	3.1	5.6	8.2	10.8	13.9

Whether hand lines or small lines were used the average catches of cod and codling on the Buckie fishing grounds were highest from November to March and lowest in the summer months of June, July and August.

Annual Fluctuations in the Catches. Only in the three northern districts was the hand line fishing carried on with sufficient regularity and intensity to give reliable data for the calculation of the average monthly catches throughout the whole period. In the other parts of the Firth the fishing was prosecuted in a somewhat desultory fashion and there are therefore numerous gaps in the records which cannot readily be bridged. The analysis of the catches has therefore been confined to the three northern districts and in order to compare the fluctuations in the average weights of cod caught annually by hand lines in these districts the same device has been adopted as in the case of the small lines. The year has been assumed to begin in August and the average catches in cwts. per 100 shots for each month of the "codling" year have been summed to obtain the appropriate index figures to represent the fluctuations in the relative weights of the species in the catches from year to year.

Cod and Codling. — Hand Lines 1904—1916 (incl.).

Summation of Average Monthly Catches in cwts. per 100 shots for the year ended July.

	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
Helmsdale...	1601	1864	2266	2316	1951	1872	3366	2954	1717	1739	2099	1605
Lybster.....	2064	2086	2549	3085	2042	2224	3490	2986	2561	1787	1833	1861
Wick.....	1509	1881	1764	1667	1604	1812	2793	4223	3662	2515	2672	2385
Mean....	1725	1944	2193	2356	1866	1969	3216	3388	2647	2014	2201	1950

There were considerable fluctuations in all three districts. It would appear from the evidence available that the cod were not uniformly distributed along the coastal zone in the north-western area of the Firth but that the concentrations

varied in density and disposition from year to year. The heaviest catches were, however, taken in the two more northerly districts and the greatest weight of cod concentrated in the section of the coast between Lybster and Wick, the shoals extending further south along the coast in some years than in others. In the first seven years of the period the centre of density was in the Lybster section of the coast there being a tendency for the fish to be distributed southwards along the coast towards Helmsdale. This feature appears to have been most marked in the year ended July 1911. The index figures for the Wick district for the first few years may, however, be too low as there is a suggestion in the statistics that some small line catches have been included with the records of the hand line catches. During the last five years of the period the main concentrations were in the most northerly area.

While the index figures show the degree of success attained by the hand line fishermen from year to year they can be considered as providing only a very approximate estimate of the relative abundance of cod on the different sections of the coast.

In view of the fact that there was great variation in the density and disposition of the shoals on the coast from year to year the mean values from all three areas have been combined in order to obtain some measure of the variations in the abundance of cod within this wider area. In other words by adding the average catches per 100 shots for the three areas it has been assumed that the three sections of the coast have been sampled equally each year. The mean index figures so obtained are given in the above table. It will be noted that except for the three years ended July 1911, 1912 and 1913 the index figures show only comparatively small variations. It would appear therefore that the differences in the years 1911, 1912 and 1913 are significant and that the weight of cod on the north-west ground during that period was considerably above the normal. It was deduced from a consideration of the catches of codling by small lines that the period from the year ended July 1909 to the year ended July 1913 was a group of good years in which seasons ending July 1910, 1911 and 1913 were exceptionally productive and that in all probability this succession of good "codling" years followed a succession of favourable spawning seasons. There appears to be no doubt but that the good catches obtained by hand lines in the north-western area in 1911, 1912 and 1913 were due to this same cause. If comparison is made between the catches of codling by small lines and the catches by hand lines it will be observed that the fluctuations are not in precise agreement with regard to their trend from year to year. The data for the small line catches, however, refer chiefly to catches made within the 30 fathom contour line of depth or in the shallower and inner sections of the Firth. On the other hand the 30 fathom line is in very close proximity to the coast in the north-western area and more particularly in the more northerly section. It has already been shown from an analysis of the small line catches that there is a rapid diminution of the

numbers of codling between the ages of two and three years from the shallow grounds mainly owing to their dispersal offshore. This departure of the larger fish from the shallower grounds beginning in April continues through the summer. There is no doubt but that many of the individuals find their way to the deeper but coastal grounds of the north-western area and help to maintain the catches there at a high average level in spite of the gradual departure after winter of the still older fish from that area. It would appear from the statistical evidence that the high average catches (by weight) of cod in the north-western area are due to the fact that the average age of the fish is greater than that of the fish on the shallower grounds and not because the fish are more numerous there than in other parts of the Firth. This conclusion is also supported by the fact that the average catches are invariably highest in the north-western area. The relatively small amount of variation in the catches from year to year also suggests that the stock there is dependent on more than the two younger year classes which are predominant on the shallower grounds. Unfortunately the data are not sufficiently detailed to elucidate this point and no information is available with regard to the size frequencies in the different parts of the Firth.

While it is not possible to determine from the statistics of the hand lines the changes in the abundance of codling in the Firth from year to year it is evident that during the period under review there was no indications of any progressive decline in the stock.

Summary.

The two species of most importance to the line fishery of the Moray Firth are the haddock and cod. The whiting is of relatively little value and flatfish are only of minor importance being fished for by a small number of fishermen in restricted areas at certain times of the year.

The small line fishing is by far the most important method of fishing; it contributed over 83 per cent. to the total weight of all fish caught by lines within the Firth during the period 1904—1916 (incl.). The small line fishing is mainly a fishery for haddock; the average percentage contribution of this species to the catches during the above period was 70. The most intensive fishery is carried on during the fourth and first quarters of the year when the larger categories of haddock are relatively most abundant. The area fished by the small line fishermen, however, is not an important spawning area for the species and a large number of the mature haddocks depart from the small line grounds before the advent of the spawning season. The younger year classes in the Firth are recruited mainly from the progeny of the spawning shoals beyond the limits of the Firth. This recruitment may take place by the more or less passive transference of the pelagic forms into the Firth or by their active immigration as bottom forms at a later

date. Spawning takes place in the spring months but it is not until the middle of the following summer that the quickest growers make their appearance in the market category "smalls". At the end of the second winter some of the quicker growers have reached maturity and leave with the older mature forms for the offshore spawning grounds. In the third summer all the brood reach marketable size and many have grown sufficiently fast to be classed as "medium" fish. At the end of the third winter practically all have reached mature size and depart for the offshore spawning grounds. After the spawning there is a coastward migration of the adult fish. The influence of this wave of adult immigrants which begins to be felt about September does not pass off until the following spring. There is thus a summer-autumn migration of the adult fish into the Firth for feeding and a winter-spring emigration of the mature forms to the offshore spawning grounds. This offshore and inshore movement of the adult population of the Firth is repeated with the greatest regularity every year and affects practically every part of the Firth. The greatest concentrations of adult fish appear, however, to occur along the north-west coast. During the summer months the small line fishermen are dependent mainly on the stationary population composed largely of individuals of the younger year classes, while in the winter-spring period, the measure of their success is due to the magnitude of the invasion of the adult fish.

Spawning is an annual event and hence recruitment of the stock takes place every year. During the period 1904—1916 (incl.) the annual contributions to the Moray Firth population were very unequal. There were three years in which the conditions were exceptionally favourable to the recruitment of the Moray Firth stock of haddock. These favourable brood years were 1904, 1909 and 1913 respectively, and the progeny of these brood years began to appear amongst the "smalls" in the following summers. It was not until the years 1906, 1911 and 1915, however, that they appeared in greatest numbers and characterised the years as ones in which small haddock were extremely plentiful. The influence of these successful broods became most apparent in the years 1907, 1912 and 1916 respectively when having grown sufficiently large they dominated the catches of the larger market categories. Owing to the great reduction in numbers in the following years the influence of these broods on the catches quickly disappeared. Accessions to the stock of the Moray Firth by the progenies of the other years of the period appear to have been very moderate or poor. The effects of these alternate good and bad brood periods are so marked that over such a short period they mask any progressive changes in the stock which may be due to other causes such as fishing.

The cod is the characteristic species of both the great line and hand line catches in the Moray Firth area. Both these methods of line fishing are, however, comparatively unimportant. Prior to 1900 great line fishing was of considerable importance, but with the advent of the steam drifter this method of fishing was very quickly abandoned and in 1904 only a few crews were prosecuting the fishing

regularly. The period of most intensive fishing was then the early months of the year when the heaviest catches of cod were procured. With the introduction of the method of cod-net fishing into the Firth in 1906 most of the crews abandoned this method of fishing and by the year 1916 it was practically extinct, only a few crews now making irregular shots for hake and skate mainly in the summer and autumn months.

The hand line fishing is a coastal fishery confined practically to the north-western area of the Firth. It is also carried on to a small extent in the Cromarty and Buckie districts but only in a very desultory fashion. During the period under review hand line fishing contributed approximately 15 per cent. of the gross weight of line fish caught in the Firth. The catches consist almost entirely of codling. The most intensive period of the fishing is from April to September. The heaviest catches are obtained along the north-western coast, the greatest concentrations of the young year classes on which the fishery is based appearing to take place between Clyth Ness and Noss Head. The older year classes leave the shallow water area and scatter, the large and mature fish only concentrating on these grounds in the spring months during the spawning season. Owing to a succession of favourable spawning years the catches of codling steadily improved and reached their best in seasons 1911, 1912 and 1913. There is no evidence either in the statistics of the small line catches or in those of the hand lines during the period 1904—1916 of a progressive reduction in the stock of codling in the Moray Firth.

Table I.

Great Lines.

1904—1916 (incl.).

Number of Shots Yearly and Weights of Species Caught in cwts.

Year	No. of Shots	Cod	Haddock	Ling	Tusk	Saithe	Turbot	Halibut	Conger Eel	Hake	Skates & Rays	Other Kinds	Total
1904	690	2028	5	342	—	142	17	128	274	—	664	11	3611
1905	584	1329	13	134	3	75	—	126	302	—	285	2	2269
1906	612	3277	—	245	32	292	—	221	200	—	588	—	4855
1907	709	3174	1	225	4	273	1	143	147	—	431	—	4399
1908	283	950	10	166	3	68	—	66	171	—	205	—	1639
1909	398	839	—	24	—	3	—	78	83	10	57	—	1094
1910	255	525	80	19	—	43	—	69	9	—	2	—	747
1911	120	308	—	83	—	36	2	31	32	—	79	—	571
1912	365	1585	—	19	—	10	—	64	124	—	116	—	1918
1913	258	873	—	19	—	—	—	66	98	—	16	—	1072
1914	225	457	—	49	—	—	1	50	299	—	61	23	940
1915	61	135	61	—	—	—	—	5	64	—	24	1	290
1916	77	44	—	—	—	2	—	5	109	22	51	—	233
	4637	15524	170	1325	42	944	21	1052	1912	32	2579	37	23638

Table II.

Small Lines.

1904—1916 (incl.).

Number of Shots Yearly and Weights of Species Caught in cwts.

Year	No. of Shots	Cod	Haddock	Whiting	Saithe	Flat Fish	Ling	Skates & Rays	Other Kinds	All Kinds
1904.....	32863	10304	55394	4439	77	3742	26	35	549	74566
1905.....	31542	9975	47547	5293	26	4178	46	13	289	67367
1906.....	29742	9170	60884	4613	37	4703	6	6	168	79587
1907.....	29854	9931	69603	4103	4	5554	—	—	54	89249
1908.....	28922	10971	53134	8604	40	6754	—	—	209	79712
1909.....	22007	12673	31261	2289	16	4354	—	—	49	50642
1910.....	23395	13595	40646	4036	19	5436	—	—	67	63799
1911.....	29755	13821	68553	3669	29	5751	—	—	36	91859
1912.....	30486	17479	67478	5748	13	6087	—	—	208	97013
1913.....	21473	13139	36842	3615	254	5798	—	—	126	59774
1914.....	24815	10073	36910	6633	20	3698	—	—	181	57515
1915.....	31273	8947	59550	8651	49	4142	—	11	181	81531
1916.....	31317	9540	54174	8857	35	5403	—	—	348	78357
	367444	149618	681976	70550	619	65600	78	65	2465	970971

Table III.

Hand Lines.

1904—1916 (incl.).

Number of Shots Yearly and Weights of Species Caught in cwts.

Year	No. of Shots	Cod	Haddock	Whiting	Ling	Saithe	Conger Eel	Mackerel	Halibut	Skates &Rays	Flat Fish	Other Kinds	All Kinds
1904	10102	9941	4540	49	50	566	10	—	15	—	66	234	15471
1905	9806	9320	2774	202	53	466	10	—	15	1	80	265	13186
1906	8371	8589	3031	119	32	532	3	—	13	9	60	—	12388
1907	5972	9505	904	—	56	595	—	—	3	—	72	96	11231
1908	6984	11250	779	291	66	321	22	—	28	16	101	93	12967
1909	6533	7657	313	3	11	189	—	—	15	2	213	120	8523
1910	6753	11490	293	—	8	117	—	—	7	7	123	89	12134
1911	8367	25218	88	20	—	607	3	—	8	—	71	56	26071
1912	7462	21670	426	12	5	438	9	—	18	7	75	24	22684
1913	4073	7914	267	4	2	377	—	—	14	7	93	40	8718
1914	5264	9591	94	—	—	327	4	—	3	6	75	16	10116
1915	6931	10508	95	238	49	208	—	908	34	13	69	—	12122
1916	5135	10198	57	13	36	372	10	14	50	31	35	—	10816
	91753	152851	13661	951	368	5115	71	922	223	99	1133	1033	176427

Table IV.

Great Lines.

1904—1916 (incl.).

Average Weight in cwts. per 100 shots.

Month	No. of Shots	Cod	Cod-ling	Had-dock	Ling	Tusk	Saithe	Tur-bot	Hali-but	Cong-er Eels	Cat-fish	Hake	Skates and Rays	Not class-ified	All Kinds
Jan....	967	205	141	2	22	—	23	2	19	31	—	—	36	—	482
Feb....	1249	237	156	4	25	2	22	—	23	23	—	—	36	—	529
March .	745	288	135	—	62	1	32	—	30	23	—	—	118	—	693
April ..	53	390	40	—	72	5	45	—	34	89	—	—	83	—	758
May...	206	81	16	5	64	1	53	—	60	37	—	5	156	—	480
June ..	215	30	8	—	7	—	25	—	45	77	—	—	75	8	276
July...	46	24	6	—	—	—	9	4	30	100	—	—	195	—	370
Aug....	77	66	53	104	14	—	—	—	6	186	—	—	18	—	448
Sep....	76	—	60	—	3	—	—	—	3	175	—	—	10	—	251
Oct....	105	3	55	—	24	—	2	—	4	186	—	—	108	—	382
Nov....	372	121	218	—	17	—	—	—	10	40	—	6	16	—	430
Dec....	526	112	294	7	9	—	2	—	8	37	—	—	15	—	479
	4637	186	149	4	29	—	20	—	23	41	—	—	56	—	510

Table V.

All Districts 1904—1916 (incl.).

Small Lines.

Average Quantity in cwts. per 100 shots.

Month	No. of Shots	Cod	Cod-ling	Hadd-ock	Whit-ing	Saithe	Lemon Soles	Flat-fish	Un-classified	All Kinds
January	37889	5	49	248	8	0.1	—	7.1	1.0	320
February.....	34231	5	48	199	7	0.2	—	41.1	1.0	304
March	25743	5	50	150	7	—	—	49.3	1.5	263
April	20494	2	43	117	7	0.2	0.1	37.3	0.9	208
May.....	22147	1	33	132	11	0.3	—	21.3	1.1	199
June	21970	0.6	20	147	32	0.4	—	11.2	0.5	212
July.....	24497	0.4	14	150	49	0.2	—	12.3	0.4	226
August	28475	0.3	14	154	43	—	—	15.2	0.8	227
September	34829	0.4	25	183	27	0.1	—	14.6	0.6	251
October.....	42877	0.4	37	201	19	—	—	10.5	0.3	268
November.....	37099	1	48	218	14	0.1	0.1	5.6	0.3	287
December	37193	2	62	224	13	0.2	—	2.5	0.5	304
	367444	2	39	186	19	0.2	—	17.4	0.6	264

Table VI.

All Districts 1904—1916 (incl.).

Hand Lines.

Average Quantity in cwts. per 100 shots.

Month	No. of Shots	Cod	Cod-ling	Had-dock	Whit-ing	Ling	Saithe	Flat-fish	Hali-but	Tur-bot	Cong-er Eels	Skate	Mack-erel	Un-class-ified	All Kinds
Jan....	5994	36	181	9	—	0.7	11	1.0	0.3	—	0.3	0.3	—	0.2	240
Feb....	5339	19	195	8	0.1	1.0	5	2.6	0.2	—	0.2	—	—	—	231
March .	7374	18	210	7	0.1	0.5	3	1.0	0.3	—	0.1	—	—	—	240
April ..	10708	23	183	3	—	0.3	2	0.7	0.2	—	—	—	—	—	212
May...	11912	32	130	9	—	0.1	4	0.5	0.3	—	—	0.1	—	0.4	176
June ..	10049	30	116	16	2.0	0.1	7	0.7	0.3	—	—	0.4	—	1.0	174
July...	9788	16	109	22	3.0	0.2	3	1.1	0.4	—	—	—	7.0	2.0	164
Aug....	9364	23	76	28	2.0	0.5	3	1.3	—	—	—	0.1	2.0	4.0	140
Sep....	6594	5	120	26	3.0	0.4	6	1.6	0.2	—	0.1	—	0.2	2.0	165
Oct....	5317	24	132	17	0.5	0.7	9	2.5	—	—	—	—	—	2.0	188
Nov. ..	4735	6	174	18	0.2	0.4	11	2.1	0.1	—	—	—	—	0.3	212
Dec....	4579	12	176	15	0.1	0.2	9	0.1	0.3	—	0.1	—	—	0.3	213
	91753	22	145	15	1.0	0.4	5.6	1.1	0.2	—	—	0.1	1.0	1.0	192

Review of the Cod Net Fishing in the Moray Firth

by

A. Bowman, D. Sc.

Introduction.

Although the method of fishing known as cod-net fishing has been in vogue on the West Coast of Scotland for almost a century, it has been practised only during the last twenty years on the East Coast, where it has assumed important proportions. The operations on the East Coast are centred in the Moray Firth and are carried on during the early months of the year. Begun there in 1906, for two years cod-net fishing attracted little attention, but the remunerative results obtained at a time of year when there is a general lull in herring fishing began to be more generally realised and in 1908 there was a great accession of activity. Since then all the districts bordering on the Moray Firth have embarked upon the enterprise and it may now be said to have become a recognised portion of the year's routine.

The detailed data showing the quantity in hundred-weights and value in pounds sterling of cod caught by cod nets each season in the Moray Firth and landed within the various Fishery Districts from the commencement of the fishery are given in Table I and the total landings and average price per cwt. are represented in the accompanying diagram (fig. 1).

The year 1909, the fourth year of this enterprise in the Moray Firth, saw the method well established and in seasons 1910 and 1912 the aggregate landings of large cod exceeded sixty-nine and sixty-seven thousand cwts. respectively, figures which have never since been attained. The year 1910 appears to have been one of exceptionally heavy catches, individual landings of from 800 to 1000 fish having been frequently recorded. In that year fishing with anchored nets was engaged in chiefly from Lossiemouth, Hopeman and Burghead, and best results were obtained during the month of March. The success attained in 1910 inspired hopes for the following year which were not fulfilled. Season 1911 was, indeed, a pronounced failure, the shoals apparently being much less dense than in the previous year and

Table I.

Cod Net Fishing 1906-1926.

Total Quantities and Values and Percentage Contribution from each Fishing District.

	1906		1907		1908		1909		1910	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh ...	—	—	—	—	—	—	111	42	160	52
per cent.	—	—	—	—	—	—	*.3*	*.3*	*.2*	*.2*
Banff.....	990	510	1305	575	6353	2620	6479	2778	5228	2255
per cent.	*59.3*	*64.5*	*68.0*	*67.6*	*72.8*	*69.1*	*17.9*	*21.9*	*7.5*	*9.1*
Buckie.....	634	263	613	276	82	35	949	291	8749	3680
per cent.	*37.9*	*33.2*	*31.9*	*32.4*	*.9*	*.9*	*2.6*	*2.3*	*12.6*	*14.8*
Findhorn.....	46	18	—	—	2292	1137	25069	8408	48725	16765
per cent.	*2.7*	*2.3*	—	—	*26.3*	*30.0*	*69.2*	*66.3*	*70.2*	*67.4*
Cromarty	—	—	—	—	—	—	252	79	673	236
per cent.	—	—	—	—	—	—	*.7*	*.6*	*1.0*	*.9*
Helmsdale.....	—	—	—	—	—	—	1408	367	1623	430
per cent.	—	—	—	—	—	—	*3.9*	*2.9*	*2.3*	*1.7*
Wick	—	—	—	—	—	—	1945	714	4251	1452
per cent.	—	—	—	—	—	—	*5.4*	*5.6*	*6.1*	*6.8*
	1670	791	1918	851	8727	3792	36213	12679	69409	24870
Average Price per cwt.	9/6		8/10		8/8		7/-		7/2	

	1911		1912		1913		1914		1915	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh ...	42	19	695	219	140	63	171	97	179	100
per cent.	*.1*	*.1*	*1.3*	*.8*	*.2*	*.2*	*.4*	*.4*	*.5*	*.4*
Banff.....	2820	1284	11279	3619	7516	3560	4903	2608	4182	3867
per cent.	*8.6*	*9.2*	*16.7*	*14.5*	*13.5*	*13.7*	*11.9*	*12.0*	*13.1*	*15.0*
Buckie	9760	4502	17129	6402	22807	9852	18906	9498	13860	11772
per cent.	*29.8*	*32.2*	*25.5*	*25.7*	*40.9*	*37.9*	*45.9*	*43.7*	*43.4*	*45.6*
Findhorn.....	14017	5820	28562	11461	20323	10463	13714	7942	8090	6394
per cent.	*42.9*	*41.6*	*42.5*	*45.9*	*36.4*	*40.3*	*33.3*	*36.5*	*25.4*	*24.8*
Cromarty	268	88	721	160	170	52	387	15	235	137
per cent.	*.8*	*.6*	*1.0*	*.6*	*.3*	*.2*	*.9*	*.1*	*.7*	*.5*
Helmsdale.....	1858	627	1727	554	1381	405	1018	404	2232	1826
per cent.	*5.7*	*4.5*	*2.5*	*2.2*	*2.5*	*1.6*	*2.5*	*1.8*	*7.0*	*7.1*
Wick	3964	1650	7048	2543	3473	1547	2050	1172	3108	1702
per cent.	*12.1*	*11.8*	*10.5*	*10.2*	*6.2*	*5.9*	*5.0*	*5.4*	*9.7*	*6.6*
	32729	13990	67161	24958	55810	25942	41149	21736	31886	25798
Average Price per cwt.	8/6		7/5		9/3		10/7		16/2	

Table I (continued).

	1916		1917		1918		1919		1920	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh ...	95	122	584	831	480	1794	689	1256	534	1005
per cent.	*.3*	*.3*	*1.7*	*1.3*	*1.2*	*1.1*	*1.6*	*1.2*	*1.5*	*1.9*
Banff.....	3052	4754	3987	8027	2073	10238	3464	8289	2585	3731
per cent.	*8.2*	*11.9*	*11.3*	*12.4*	*5.0*	*6.2*	*8.0*	*8.1*	*7.2*	*7.3*
Buckie.....	11845	13255	13218	28038	14141	69505	17427	45346	18038	28537
per cent.	*31.8*	*33.3*	*37.5*	*43.1*	*34.4*	*42.1*	*40.7*	*44.4*	*50.1*	*56.5*
Findhorn.....	5283	6207	4625	8572	7562	27720	10571	26046	10473	12075
per cent.	*14.1*	*15.6*	*13.1*	*13.2*	*18.4*	*16.8*	*24.7*	*25.4*	*29.1*	*23.9*
Cromarty	—	—	831	1036	455	1000	1653	3389	683	653
per cent.	—	—	*2.3*	*1.5*	*1.1*	*.6*	*3.9*	*3.3*	*1.9*	*1.3*
Helmsdale.....	3074	3404	2156	3016	3366	10264	3152	5840	2029	2649
per cent.	*8.2*	*8.6*	*6.1*	*4.6*	*8.2*	*6.2*	*7.4*	*5.7*	*5.7*	*5.2*
Wick	13980	12047	9815	15492	13059	44466	5846	12033	1614	1897
per cent.	*37.4*	*30.3*	*27.9*	*23.8*	*31.7*	*26.9*	*13.7*	*11.7*	*4.5*	*3.8*
	37329	39789	35216	65012	41136	164987	42802	102199	35956	50547
Average Price per cwt.	21/4		36/11		80/2		47/9		28/1	

	1921		1922		1923		1924		1925	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Fraserburgh ...	646	853	502	648	386	449	880	1130	539	610
per cent.	*1.6*	*2.0*	*1.8*	*2.9*	*1.6*	*1.9*	*5.5*	*6.2*	*4.1*	*4.1*
Banff.....	5084	4454	1621	1554	1398	1516	1270	1560	679	1106
per cent.	*12.8*	*10.6*	*5.8*	*6.9*	*5.8*	*6.6*	*7.9*	*8.6*	*5.2*	*7.4*
Buckie.....	21215	24231	17261	14052	16268	14928	10352	11895	9149	10550
per cent.	*53.3*	*57.7*	*61.0*	*62.7*	*67.8*	*65.2*	*65.1*	*65.8*	*69.6*	*70.6*
Findhorn.....	7829	7909	5369	3892	3951	4318	2326	2592	873	1075
per cent.	*19.7*	*18.8*	*18.9*	*17.3*	*16.4*	*18.9*	*14.6*	*14.3*	*6.6*	*7.2*
Cromarty	302	329	274	230	226	229	65	55	174	154
per cent.	*.7*	*.8*	*1.0*	*1.0*	*.9*	*1.0*	*.4*	*.3*	*1.3*	*1.0*
Helmsdale.....	1600	1581	1567	1265	981	909	743	644	1094	921
per cent.	*4.0*	*3.8*	*5.5*	*5.6*	*4.1*	*3.9*	*4.7*	*3.6*	*8.3*	*6.2*
Wick	3148	2640	1687	785	800	534	270	205	634	525
per cent.	*7.9*	*6.3*	*5.9*	*3.5*	*3.3*	*2.3*	*1.7*	*1.1*	*4.8*	*3.5*
	39824	41997	28281	22426	24010	22883	15906	18081	13142	14941
Average Price per cwt.	21/1		15/10		19/1		22/9		22/9	

Table I (continued).

	1926		Total 1909—1926 (incl.)	
	Cwts.	£	Cwts.	£
Fraserburgh	167	162	7000	9452
per cent.	*1.3*	*1.3*	*1.06*	*1.34*
Banff	94	140	67714	65340
per cent.	*.7*	*1.1*	*10.24*	*9.26*
Buckie	10074	9857	251148	316191
per cent.	*78.6*	*79.5*	*38.01*	*44.83*
Findhorn	1374	1350	218736	169009
per cent.	*10.7*	*10.9*	*33.10*	*23.97*
Cromarty	179	176	7548	8018
per cent.	*1.4*	*1.4*	*1.14*	*1.14*
Helmsdale	827	631	31836	35737
per cent.	*6.4*	*5.1*	*4.82*	*5.06*
Wick	104	76	76796	101480
per cent.	*.8*	*.6*	*11.62*	*14.39*
	12819	12392	660778	705227
Average Price per cwt.	19/4			

the total catch for the season fell to less than thirty-three thousand cwts. In 1912 individual catches which, while considerably below the outstanding level of 1910, were much better than those of 1911, frequently ranged between 200 and 600 fish. The small aggregate catch for season 1911, coming between the two bumper years of 1910 and 1912, cannot be ascribed to diminished effort on the part of the fishermen but simply to the fact that the shoals were much less dense in that year. In the following years the seasons' totals steadily dropped until in 1914 the season's aggregate was back to the level of that of 1909. Thus the fluctuations in the total landings in these pre-war seasons when fishing was being carried on with vigour suggest that conditions are much more favourable in some years than in others for mature cod entering the waters of the Firth for the purpose of spawning.

During the war years when operations were considerably restricted the season's totals maintained a very steady level, but after the war from 1922 onwards there was a very marked decline. It must be noted, however, that Danish seine net fishing was introduced into the Firth in the autumn of 1921 and a number of boats turned their attention to the new method of fishing.

In spite of the fact that the cod are caught at a period when fish are normally abundant on the markets, the average price of cod caught by cod nets maintained a uniformly good level. Naturally the average prices realised fall into three periods, namely pre-war, war and post-war. The graph of the average prices per

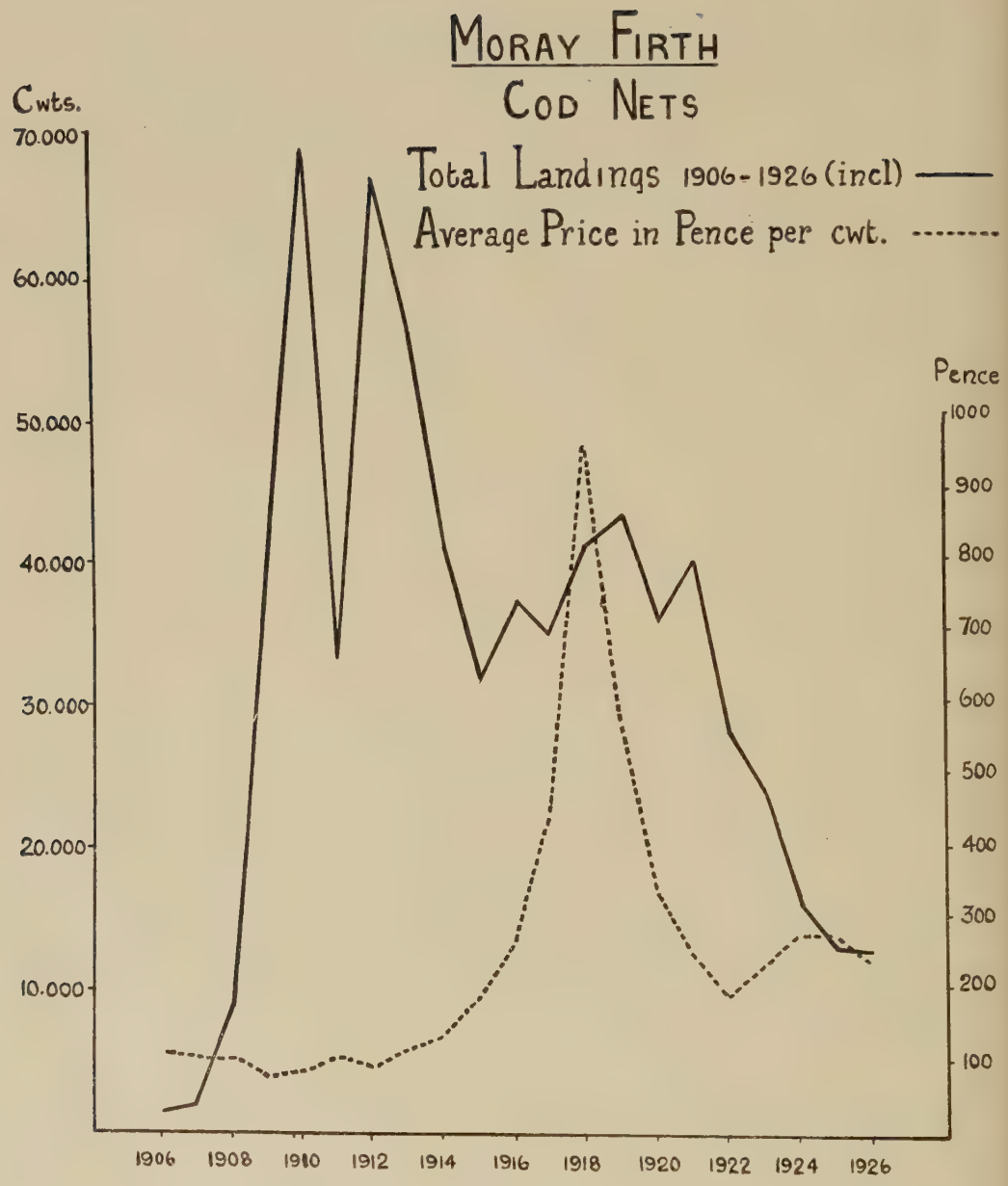


Fig. 1.

cwt. shows the phenomenal rise during the war period to reach an unprecedented height in season 1918. From that year the average price rapidly fell but during the last four seasons of the period with diminished catches the prices remained over 100 per cent. above pre-war level.

Description of the Nets and Procedure.

The nets used in cod net fishing are made of 18 ply yarn, 120 yards in length and 7 yards in depth, with a 9 inch mesh. It is stated that prior to 1912 the crews of steam and large sail vessels in the Wick district used the same length of net as above but finding that a shorter net made fishing easier the fishermen introduced the 80 yard net which has been in use in that district since that time.

As compared with the old type of cod net several improvements have been introduced. The corks formerly used for keeping the net in an upright position have been replaced by strong hollow glass balls, about one pound in weight and five inches in diameter, which are covered with canvas to prevent breakage and to enable ropes to be attached to them. These balls retain their buoyancy while corks, tending to become water-logged after a time, cease to be of service owing to the pressure at any great depth forcing the water into the pores of the cork. The stones formerly used for weighting the bottom of the nets have been replaced by small sandbags of about six pounds in weight and from 14 to 16 inches in length. When mounted the 120 yard net is contracted to 60 yards in length and owing to its loose setting the fish usually become entangled in the loose folds of the net.

Steamers carry from 45 to 50 nets while large motor boats and large sail boats each employ on an average from 35 to 40 nets. In the Wick district the average number of nets shot by the crews carrying the shorter nets of 80 yards are 70, 65 and 50 for steam, large motor, and large sail vessels respectively. The number of nets used by the smaller vessels varies according to the size of the craft. Small motor boats usually have from 20 to 30 nets but some of the third-class sailing yawls may carry as few as six.

In the Findhorn district cod-net fishing was commenced by sail boats in 1908 when the average number of nets was sixteen but no bush rope or messenger was then in use. In 1909 when steamers were first fitted out for this method of fishing the bush rope was introduced and the average number of nets was then increased. The nets are placed in series, the foot ropes of the nets being attached at intervals by means of "stoppers" to the bush rope or messenger used for shooting and hauling the fleet. The "stoppers" are usually about six fathoms in length and are used between the foot rope of the net and the bush rope to obviate, as far as possible, the loose net becoming wrapped round the bush rope during the operations of shooting and hauling.

By the end of the year 1918 most of the sailing boats which engaged in cod-net fishing had had motor engines installed and after that time the sail boats which participated in cod net fishing were chiefly those of a very small size. The introduction of motor power gave greater mobility to the fleet.

The procedure generally adopted by the fishermen is to set and anchor their fleet of nets and then return to port. The larger vessels fishing from ports on the

south side of the Firth often seek the shelter of Wick harbour over night if the fishing grounds are in the neighbourhood of the Caithness Coast. If the weather is suitable the boats proceed to the fishing grounds on the following day and the fishermen haul, clear, and re-set the fleet of nets and return to port with the catch; but in the event of bad weather some days may elapse before the nets can be examined.

Most of the catches by the larger vessels are landed at ports on the south side of the Firth where the best facilities for the disposal of the catches exist, but occasionally owing to various reasons, such as the position of the fishing grounds, adverse weather conditions etc. the catches may be landed at other ports. Very little has been done at cod net fishing by the fishermen of the Wick district since the year 1919, almost all the net caught cod recorded having been landed by stranger crews.

The bulk of the fish is despatched in a fresh state to the southern markets, chiefly to Glasgow, London and Midland towns, but a small proportion of the catch may be split and cured for exportation.

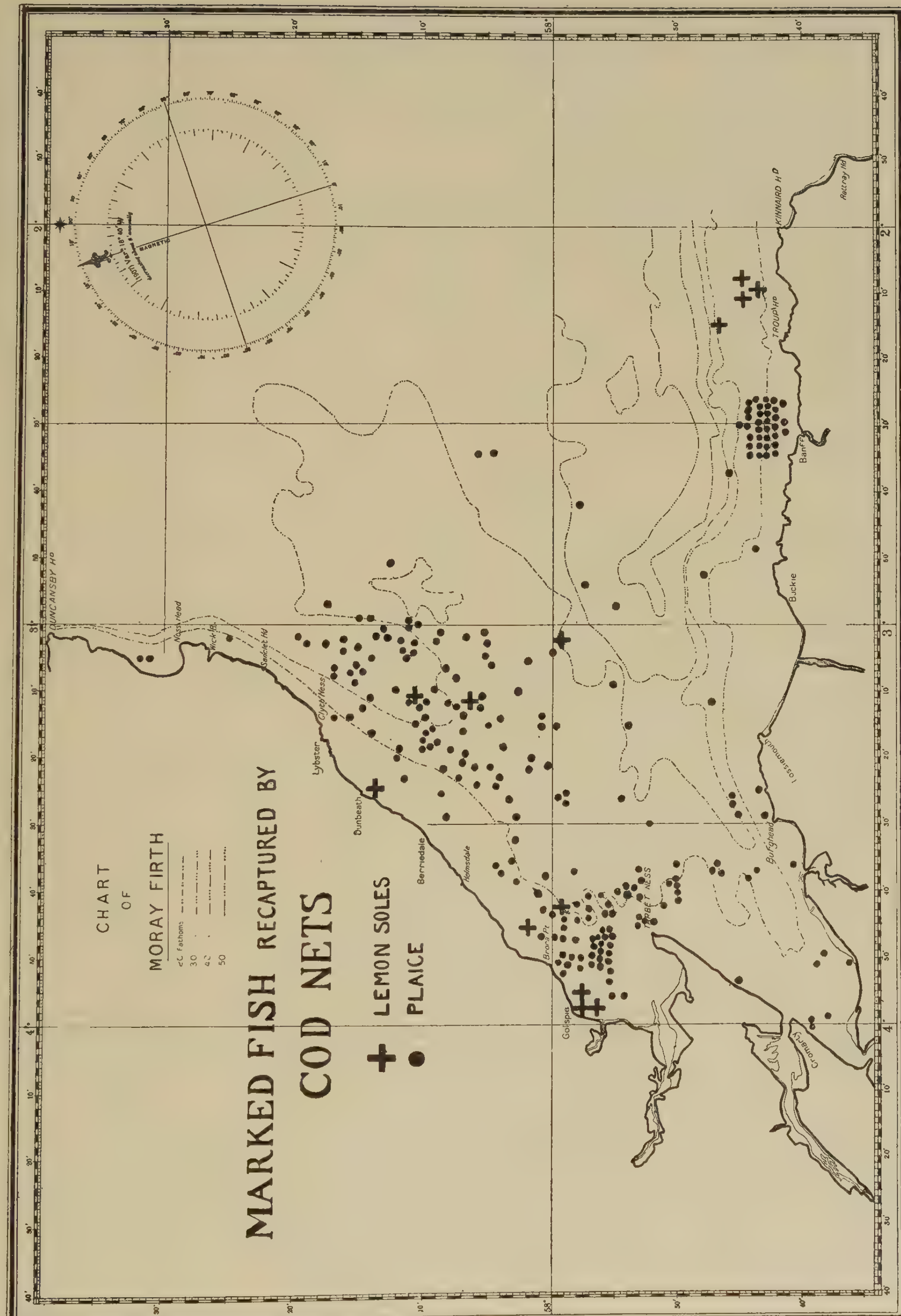
The Fishing Grounds.

The fishing grounds most frequented by the cod-net fishermen are situated off the north-west shore of the Firth, for in addition to the boats from the neighbouring creeks the larger craft from ports on the south side also frequent this extensive area. The loci of fishing vary from year to year but the most favoured fishing grounds lie between Clyth Ness and Tarbet Ness within ten miles of the coast, the fishermen preferring to set their nets on the edges of the banks. Although cod nets are not adapted for the capture of flatfish, the accompanying chart (p. 157), on which have been noted the localities of recapture by cod nets of marked plaice and lemon soles, gives some idea of the extent of area covered by the cod-net fishermen in their operations.

Distance from the home port is naturally a factor in the selection of the fishing grounds even in the cases of the large steam and motor vessels. While large vessels from Fraserburgh, Banff and Buckie may cross the Firth to fish off the north-west shore, they are also found in the intermediate area off Tarbet Ness up to 15 and 20 miles offshore.

In the most northerly section of the Moray Firth area off Noss Head the tides are as a rule too strong for successful cod-net fishing. In all probability this is the reason why the Wick fishermen who are nearest to that area have preferred the 80 yard net to that of 120 yards used by the other fishermen.

In short, most of the cod-netting operations by the larger vessels are carried on within the inner area of the Firth to the west of the line 3° West longitude, the disposition of the vessels depending in great measure on the distance of the


MARKED FISH RECAPTURED BY
COD NETS
LEMON SOLES
PLAICE
CHART
OF
MORAY FIRTH
Lybster
Dunbeath
Berriedale
Helmsdale
Golspie
Buckie
Banff
Burghead
Lossiemouth
Cromarty
KINNAIRD HD
TROUP HD
TARBET NESS

most productive fishing grounds from their home ports. The distribution of the shoals of mature cod varies from season to season but in these seasons when the shoals are dense in a comparatively restricted area the larger boats usually concentrate on these grounds and the long fleets of nets may often be set not much more than a quarter of a mile apart.

The sphere of operations of the smaller boats is much more restricted, although in this case the introduction of motors has given the boats greater choice of grounds. These smaller boats usually fish in the neighbourhood of their home ports up to a distance of approximately five miles from the shore and operations are carried on along practically every section of the coast. The smaller boats based on Fraserburgh usually set their nets in the coastal area off Troup Head alongside those of the Banff fleet. The Dornoch Firth is also an area which the smaller boats from the neighbouring creeks appear to find most favourable for their operations.

The Fishing Season.

Cod-net fishing operations for mature cod in the Moray Firth are confined to the earliest months of the year. The commencement of the season varies in the different years but operations by the smaller boats usually begin tentatively in the first weeks of January and with the arrival of the mature fish in numbers in the Firth the fleet is rapidly augmented and fishing is carried on intensively by all classes of vessels during the spawning concentration, the number of vessels engaged in the fishing gradually dwindling thereafter as the shoals break up and the percentage of spent fish in the catches increases.

The course of events each year is very similar and the progress of the fishing in the different seasons is briefly summarised in Table II. The total weights and values of the catches landed within the various Fishery Districts at the end of each week throughout the season are given in the original data and from these the beginning and end of the season, and the dates by which one-quarter, one half, and three-quarters of the total landings for the season have been obtained are readily ascertained. Thus in eight of the thirteen years 1914—1926 (incl.) for which complete data are available half of the total catch for the season had been secured by the first week in March, the middle date of the season being practically the same in each of these years. Of the remaining five years, season 1921 may be considered as an early one in which half of the catch was procured as early as February 21st. In this early season the middle half of the catch was gathered between the 11th February and 5th March — a period of three weeks — and operations which began on January 11th terminated as early as April 9th. The remaining four years namely 1915, 1916, 1923 and 1925 may be considered as comparatively late seasons, half of the catch not being obtained until the second week in March, the respective dates being 14th, 10th, 12th and 10th.

Table II.

Cod Net Fishing.

Seasonal Progress of the Fishing.

		Approximate Dates for the Season					No. of Days to secure Middle Half of Catch	Total
		Opening	One Quarter	One Half	Three Quarters	Close		
1914	Quantity	Jan. 22	Febr. 20	March 4	March 15	April 18	23	41149 cwts.
	Value	—	— 19	— 3	— 14	—	23	£ 21736
1915	Quantity	— 18	March 3	— 14	— 25	May 1	22	31886 cwts.
	Value	—	— 2	— 14	— 27	—	25	£ 25798
1916	Quantity	— 6	Febr. 25	— 10	— 23	April 29	27	37329 cwts.
	Value	—	— 20	— 8	— 24	—	33	£ 39798
1917	Quantity	— 5	— 17	— 4	— 23	May 13	34	35216 cwts.
	Value	—	— 16	— 3	— 27	—	39	£ 65012
1918	Quantity	— 4	— 16	— 2	— 15	— 11	27	41136 cwts.
	Value	—	— 15	Febr. 28	— 13	—	26	£ 164987
1919	Quantity	— 9	— 15	March 3	— 19	April 29	32	42802 cwts.
	Value	—	— 14	— 3	— 19	—	33	£ 102199
1920	Quantity	— 13	— 21	— 3	— 14	May 1	22	35956 cwts.
	Value	—	— 15	— 1	— 14	—	28	£ 50547
1921	Quantity	— 11	— 12	Febr. 21	— 5	April 9	21	39824 cwts.
	Value	—	— 9	— 22	— 8	—	27	£ 41997
1922	Quantity	— 13	— 22	March 4	— 15	— 22	21	28281 cwts.
	Value	—	— 9	Febr. 25	— 7	—	26	£ 22426
1923	Quantity	— 8	— 26	March 12	— 21	— 28	23	24010 cwts.
	Value	—	— 16	— 5	— 20	—	32	£ 22883
1924	Quantity	— 9	— 14	— 2	— 15	— 5	30	15906 cwts.
	Value	—	— 11	Febr. 22	— 11	—	29	£ 18081
1925	Quantity	— 14	— 23	March 10	— 18	— 11	23	13142 cwts
	Value	—	— 13	— 3	— 15	—	30	£ 14941
1926	Quantity	— 18	— 18	— 1	— 14	— 3	24	12819 cwts.
	Value	—	— 14	Febr. 26	— 12	—	26	£ 12392

It will be seen from the table of values that half of the total value of the catch is procured within a period of approximately four weeks when the fishing is most intensive.

The District Contributions.

The total landings and values of the cod net fishing for each season in each district and their percentage contributions to the gross annual totals of cod caught by cod nets in the Moray Firth are given in Table I.

Cod-net fishing was not firmly established in the Firth until the year 1908 but thereafter it has been prosecuted from all creeks on the coast with varying degrees of intensity.

The following are the weights in cwts. and the gross values of cod landed within each district during the period 1909—1926 (incl.).

District:	Total Weight in cwts.	Percentage	Total Value in £	Percentage
Fraserburgh	7000	1.06	9452	1.34
Banff	67714	10.24	65340	9.26
Buckie	251148	38.01	316191	44.83
Findhorn	218736	33.10	169009	23.97
Cromarty	7548	1.14	8018	1.14
Helmsdale	31836	4.82	35737	5.06
Wick	76796	11.62	101480	14.39

Over eighty per cent. of the total weight and value of net caught cod have been landed within the three districts of Buckie, Findhorn and Wick.

The variations in the relative importance of those three Fishery Districts are illustrated in the diagram (fig. 2).

The district of Findhorn took the lead when cod-net fishing was introduced into the Firth and in the years 1909 and 1910 approximately 70 per cent. of the total catch for each of these two years was landed there. Lossiemouth was the chief centre of the fishing but catches were also landed at Burghead, Hopeman and Nairn. Indeed, cod-net fishing was then considered as the principal local fishery. The 55 crews who engaged in the fishery in 1910 met with great success, but the following season was a complete failure, and although 65 crews fitted out their vessels the total weight landed was less than a third of that of the previous year. There was a considerable improvement in the total landings in 1912 when 15 steamers and 64 sail boats participated in the operations. Thereafter the relative importance of the district for the landing of cod caught by cod nets steadily declined until in 1926 only 10 per cent. of the total catch in the Firth was contributed by the operations of one steamer and 6 motor boats. Before the war there was a tendency for an increasing number of steamers to engage in this fishing and in season 1914, 32 of these fitted out. On the other hand the number of sail boats rapidly declined, only 34 operating in 1914. During the war no steamers were available and the fishing was carried on by a very small number of motor and sail boats. After the war the same vigour was not displayed in the prosecution of the fishery and while the number of steamers and large motor boats increased, the vessels met with only moderate success. In season 1921, 18 steamers, 27 motor boats and two small sail boats prosecuted the fishing from the district ports. On the introduction of the Danish seine net method of fishing into the Firth in the autumn of that

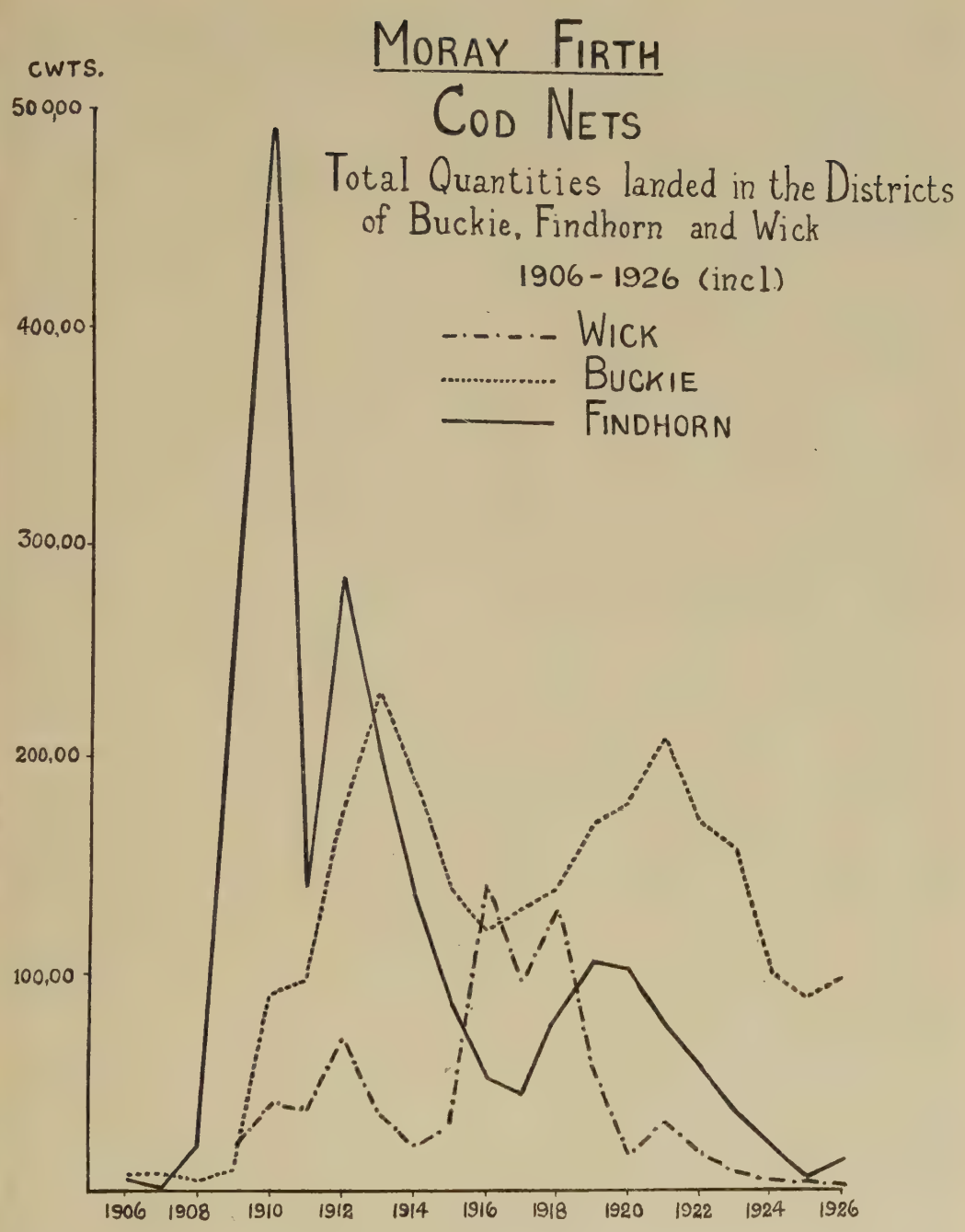

MORAY FIRTH
COD NETS
Total Quantities landed in the Districts of Buckie, Findhorn and Wick
1906 - 1926 (incl)
WICK
BUCKIE
FINDHORN
CWTS.
500,00
400,00
300,00
200,00
100,00
1906
1908
1910
1912
1914
1916
1918
1920
1922
1924
1926

Fig. 2.

year, most of the crews of the larger vessels adopted the newer method, and much less attention was given to the cod-net fishing in each succeeding year.

Although for the first few years operations from Buckie were conducted on a comparatively modest scale, the district rapidly improved its position and from 1920 onwards Buckie became the main centre for the prosecution of the cod-net fishing; more than half the gross catch taken within the Firth by this method is now landed there. In 1910 fourteen steamers and twelve large sail boats prosecuted the fishing during the early spring months. In these earlier years, however, the method apparently did not find much favour with the steamers, the increased catch being ascribed almost entirely to the activities of the large sail boats. In season 1913, the best year of the period for weight of fish landed, one steamer only participated, but the number of sail boats had increased to 83. Three steamers and 55 large sail boats contributed to the diminished landings in 1914. In this year the first motor boat from the district was fitted out for the fishing. The landings were low during the war years; steamers were not available but motors were being rapidly installed into the large sail boats. After the war the total weight of fish landed per season gradually improved, to reach the highest level in 1921 when there was again a steady fall until the end of the period. In 1919, 76 vessels consisting of 2 steamers, 38 motor boats and 36 sail boats fitted out and in 1921, the best post-war year for landings, 15 steamers, 72 motor boats and 16 sail boats were engaged. In season 1926, 57 vessels (23 steam, 22 motor drifters, 1 motor yawl and 10 sail yawls) employing about 400 fishermen were engaged in the fishing. There has been a gradual elimination of the large sail boat, a number of these having had motors installed. The increased attention given to cod-net fishing by the larger vessels after the war received a check on the introduction of the Danish seine net. The landings in the Buckie district present some features of special interest both during the earlier period when the district was contributing only a small proportion of the total catch and during the later period when it became the premier district. While seasons 1910 and 1912 were the outstanding years for the total landings from the Firth in the pre-war period, Buckie did not reach its highest level until 1913. On the other hand in the post-war period when the total catch remained practically stationary until 1921, the landings for Buckie alone steadily improved to reach their maximum in that year.

The landings in the Wick district have been very variable. In the good years of 1910 and 1912 the contributions at Wick amounted to 12 and 14 per cent. respectively of the total catch, while in the war seasons 1916, 1917 and 1918, 37, 28 and 33 per cent. respectively of the whole catch was landed there. As already mentioned, however, very few local crews favour this method of fishing, and the landings at Wick are helped substantially by stranger vessels which visit the port for various reasons. In 1909 when cod-net fishing was introduced into the district, 5 large sailing boats took part in the operations and in 1910 ten large sail boats

and 5 steamers belonging to Wick made use of this means of capture. In 1912, 2 steamers and 10 large sail boats contributed to the total. The fishermen of the Wick area evidently prefer the herring fishing to any other. The only Wick vessel employed in season 1926 at the cod net fishing was a small steam drifter but after working two weeks and grossing only £15 the crew took ashore their gear and discontinued the fishing.

The quantities of cod-net caught cod landed in the Cromarty and Helmsdale districts have always been small, and in no year do their contributions reach nine per cent. of the gross total weight of cod taken from the Firth during the season. The cod-net fishing was not taken up by the fishermen of the Helmsdale district until 1909 and for the first season or two some of the crews using nets mounted with corks instead of glass floats did not achieve satisfactory results. The fishing is now mostly carried on by a fleet of small boats — each carrying about 30 nets — into which motor engines have been installed. The chief centres for the operations of the fleet are Helmsdale and Golspie. At Golspie some of the crews combine small line fishing with the cod-net fishing and thus add appreciably to their earnings. As a rule the fishing begins early in January, one or two boats trying the fishing tentatively. Weather conditions, however, have considerable influence on the operations of these small craft. In the last four seasons fishing has not started before the month of February. The season usually closes in the second week of April. The period when the shoals are densest on this part of the coast coincides more or less generally with that for the whole Firth. Season 1921 was a very early year for the Helmsdale fleet; half of the total catch for the season was procured by February 24th. The year 1918, although a productive one, was comparatively late, the half of the catch not being procured until March 11th. These differences suggest that the shoals which enter the Firth may take different routes and segregate in different areas from one year to another. The best period was from 1915 to 1920 and the most productive year was 1918 when an aggregate of 3366 cwts. was secured. In the last few years the fishing in the Helmsdale district has been very unremunerative with the result that it is gradually being prosecuted with less vigour.

In the Cromarty district only second-class boats are employed at the cod-net fishing and the total landings are therefore correspondingly small. The average landings in cwts. per season for the eighteen years 1909—1926 is 419 cwts. and only in 1919 when the quantity landed amounted to 1653 cwts. did the total weight exceed 1000 cwts. This aggregate, however, was contributed to by a few stranger boats which landed a number of small catches at Portmahomack when fishing in the vicinity of Tarbet Ness.

In the Banff district where the fishery is prosecuted mainly by the smaller classes of vessels in the vicinity of the coast, cod-net fishing has never developed to any great extent. In recent years the landings have declined steadily and the

fishing is now confined almost exclusively to the port of Gardenstown. Small line and seine net fishing are held in greater favour at the other creeks of the district.

Cod net fishing has always been of comparatively little importance to the Fraserburgh district. The total weight of cod landed for the 21 year period does not exceed 7000 cwts. In season 1926 only one large motor boat and a few small motor and sail boats, employing about 28 men, engaged in the fishing. The large motor boats fished mainly off the north-west shore of the Firth while the smaller craft, setting their nets off Aberdour, land chiefly small-sized cod at Rosehearty. The grounds in the immediate vicinity of Fraserburgh are not suitable for this method of fishing.

The Vessels employed and their Landings.

Steamers, large and small motor boats and large and small sailing craft participate in the fishery, the numbers of the various types of vessels operating from the different districts varying considerably. The fishery is, however, carried on at a time of the year when weather conditions may have considerable influence on the operations of the fleet. The large power vessels are by far the most efficient. They use a bigger fleet of nets, can go further afield to the grounds where fish are most plentiful, can land their catches where convenient and they are often able to fish when smaller boats are kept in harbour by stormy weather. The installation of motor power has also given greater scope to the operations of the smaller craft.

In most cases the statistics of landings distinguish between steam, motor and sail vessels and Table III gives for each season throughout the period the de tails of the quantities and percentages landed by these vessels. The diagram (fig. 3) represents graphically the share contributed by each of these types.

When cod-net fishing was first introduced into the Moray Firth, operations were confined to sail boats. The landings by these vessels increased yearly — with a slight fall in 1911 — until a maximum was reached in the very successful season of 1912 when they landed almost 56 thousand cwts. After that year, however, the total quantities landed yearly by sail boats have steadily declined — with a slight check during the war period — to reach a very low level in season 1920. Thereafter the weight of cod landed by sail boats has remained small, only a paltry 731 cwts. being landed in season 1926.

Although steamers did not engage in the cod-net fishing until season 1909 the highest gross landing for any season was reached the second year after their introduction when a total of approximately 36 thousand cwts. was landed at the various ports. Then followed a remarkable drop in the landings in the disastrous year of 1911 and this low level was maintained until 1914. As will be seen later, the comparatively small quantities landed by steamers during these four years were due in part to diminished effort by steamer crews. It must be remembered

Table III.

Cod Nets.

Total Quantities landed by Steam, Motor and Sail Boats: 1906—1926.

Year	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
Steam	—	—	—	6647	35949	9203	9973	8924	10749	—	—
per cent.	—	—	—	*18.4*	*51.8*	*28.1*	*14.8*	*16.0*	*26.1*	—	—
Motor	—	—	—	—	—	—	601	2081	3613	4766	9304
per cent.	—	—	—	—	—	—	*0.9*	*3.7*	*8.8*	*14.9*	*24.9*
Sail	1670	1918	8727	29566	33460	23526	56587	44805	26787	27120	28025
per cent.	*100*	*100*	*100*	*81.6*	*48.2*	*71.9*	*84.3*	*80.3*	*65.1*	*85.1*	*75.1*
	1670	1918	8727	36213	69409	32729	67161	55810	41149	31886	37329

Year	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Steam	—	657	2542	3525	8270	8047	7323	4470	4798	5397
per cent.	—	*1.6*	*6.0*	*9.8*	*20.8*	*28.5*	*30.5*	*28.1*	*36.5*	*42.1*
Motor	14490	26168	31719	30645	28195	15408	14325	10076	7239	6691
per cent.	*41.2*	*63.6*	*74.1*	*85.2*	*70 8*	*54.4*	*59.6*	*63.3*	*55.1*	*52.2*
Sail	20726	14311	8541	1786	3359	4826	2362	1360	1105	731
per cent.	*58.8*	*34.8*	*19.9*	*5.0*	*8.4*	*17.1*	*9.9*	*8.6*	*8.4*	*5.7*
	35216	41136	42802	35956	39824	28281	24010	15906	13142	12819

that the steamers at this period were primarily equipped for the herring fishing. It should be noted, however, that in 1910 the contributions by steamers and sail boats to the total catch were almost equal, while in 1912 steamers contributed only a moderate share in a season when sail boats did extraordinarily well. As sail boats and steamers select somewhat different fishing grounds within the Firth the records suggest that the shoals of spawning fish were somewhat differently distributed in the two years in question. Thus the shoals appear to have been somewhat more uniformly distributed in 1910 than in 1912.

During the war period there were no landings by steamers and in the post-war period the return of the steamers to cod-net fishing has been slow.

The introduction of motor boats to cod-net fishing did not take place until season 1912, but thereafter they have played an increasingly important rôle in the fishery. The quantities landed yearly steadily increased until in season 1918 the motor boats were contributing the biggest share. Although the gross landings by all classes of vessels have gradually declined in the post-war years the share of the catch contributed by motor boats since 1918 has always exceeded 50 per cent.

Moray Firth
Cod Nets
Total Quantities of Cod landed by Steam, Motor and Sail Boats. 1906-1926 (incl.)

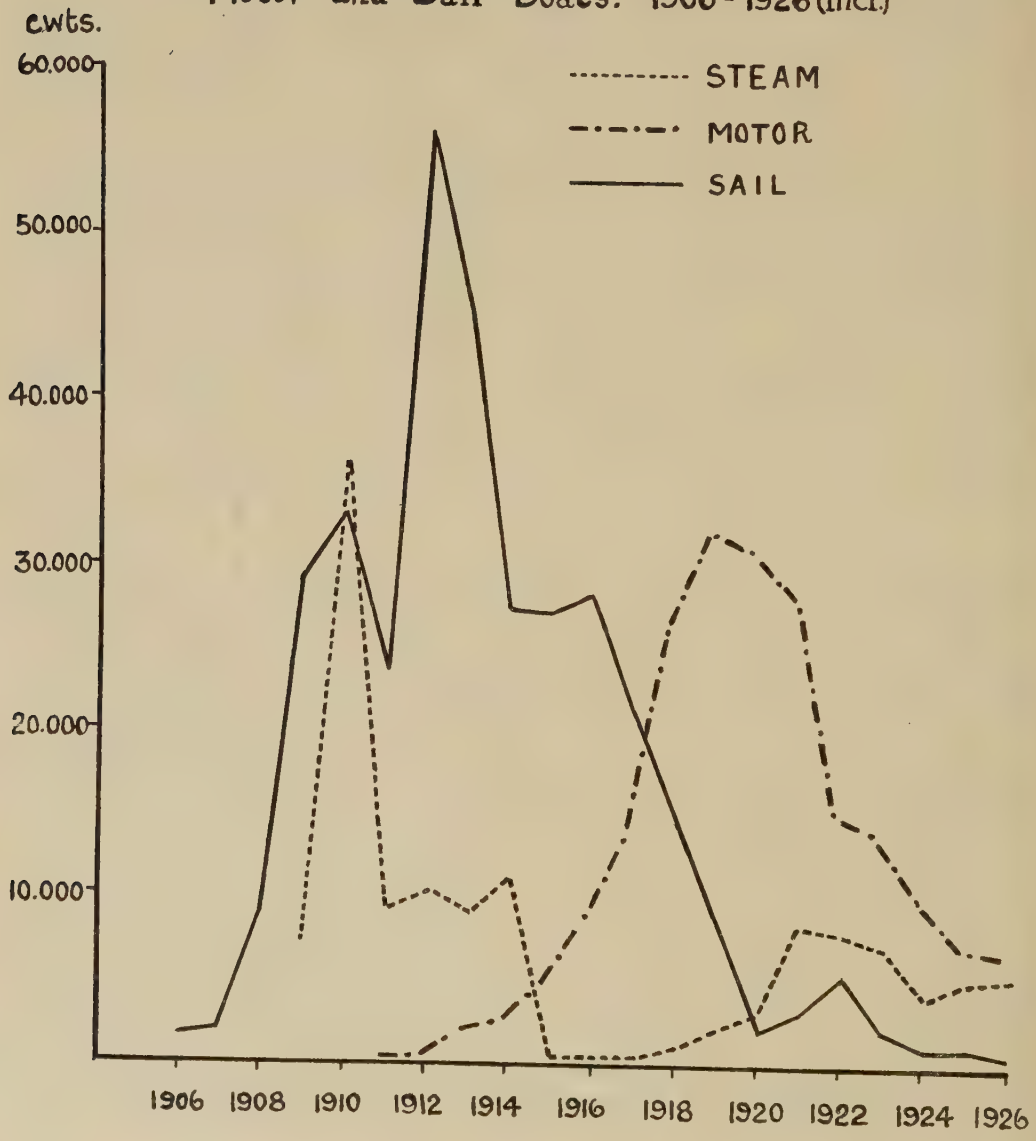


Fig. 3.

The Intensity of Fishing.

The Number of Landings.

Steamers. The statistics for the number of landings by steamers are complete and show that all — with the exception of eight — have been made within the districts of Buckie, Findhorn and Wick. In other words practically all landings by steamers are effected at the ports of Buckie, Lossiemouth and Wick. In the pre-war period of a total of 3942 landings only a little over 6 per cent. was made at Wick, while in the post-war period the percentage was approximately two in a total of 2803 landings. While the local fishermen at Wick are abandoning this method of fishing, fewer shots are being landed by stranger boats.

A comparison between the districts of Findhorn and Buckie is interesting as showing how the centre of activity for the steamers has gradually changed from Lossiemouth to Buckie.

The following are the records of landings by steamers for the whole Firth.

Number of Steamer Landings.

Year	1909	1910	1911	1912	1913	1914	1915	1916	1917
Number of Landings	158	1333	705	389	583	764	—	—	—
Year	1918	1919	1920	1921	1922	1923	1924	1925	1926
Number of Landings	50	129	191	514	288	538	288	315	490

For the pre-war period the following are the percentages of landings effected at Lossiemouth.

Cod Net Fishing — Steamer Landings.

Percentage Landings at Lossiemouth.

Year	1909	1910	1911	1912	1913	1914
Percentage	89.2	83.6	86.1	75.6	91.7	77.2

while the following are the percentages for Buckie in the post-war period:—

Year	1918	1919	1920	1921	1922	1923	1924	1925	1926
Percentage	46.0	13.9	37.2	41.4	69.1	71.4	86.8	92.4	92.0

It was season 1910 before steamers from Buckie were fitted out for this fishing and in that year fourteen steamers were equipped. The landings by steamers at Buckie in the previous year were made by Lossiemouth boats. In earlier years this method of fishing apparently did not find much favour with the Buckie steamer crews, the increased catches in the districts in pre-war years being almost entirely due to the activities of the large sail boats.

Motor Boats. The statistics for the motor boats are less satisfactory than those for the steamers. While in many cases a distinction has been drawn between large and small motor boats as to the number of landings, it is unfortunate

that the quantities landed by these two classes have not always been clearly separated.

In the season 1910 when the first motor boats were employed in cod-net fishing in the Moray Firth only ten landings were made and these were effected in the Findhorn district. As motors were installed in the sail boats the number of landings by motor boats gradually increased.

The following are the records of landings of large and small motor boats combined from 1910 onwards.

Cod Nets.

Number of Landings by Motor Boats.

Year	1910	1911	1912	1913	1914	1915	1916	1917	1918
No. of Landings	10	—	40	620	1149	1183	1671	1667	1562
Year	1919	1920	1921	1922	1923	1924	1925	1926	
No. of Landings	2494..	2787	3311	1498	1654	1237	839	813	

The increase was rapid during the first years of the war period. By 1914 the fishing under war conditions had become stabilised but there was again a rapid increase immediately after the war which reached its highest peak in 1921. After that season, however, the number of landings steadily declined until in 1926 only 813 were effected, a total below that of the year 1914.

If the records for the large motor boats, that is, those vessels carrying on an average from 35 to 40 nets, are taken separately the same post-war changes are observed in the landings.

Number of Landings by Large Motor Boats.

Year	1913	1914	1915	1916	1917	1918	1919
No. of Landings	117	107	113	201	660	991	1312
Year	1920	1921	1922	1923	1924	1925	1926
No. of Landings	1723	1727	567	882	611	377	447

There is a very marked falling off in the activities of the large motor boats after season 1921. The decrease in the landings by large motor boats and the arrest in the growth of steamer landings may be due to the fact that a number of these larger vessels turned their attention to Danish seine net fishing which was introduced into the Firth in September 1921.

Just as in the case of steamers most of the landings by large motor boats are made at the ports of Buckie, Lossiemouth and Wick and at all these three ports the falling off after 1921 is noticeable. For the period 1913 to 1926 (incl.) the number of landings at Buckie, Lossiemouth and Wick are 5384, 2498 and 1770 respect vely. In other words more than 55 per cent. of the landings have been made at Buckie. This port has only gradually assumed first place as may be seen from the following figures.

Cod Nets.

Percentage of Total Landings of Large Motor Boats made at Buckie.

Year	1913	1914	1915	1916	1917	1918	1919
Percentage Landings	56.4	45.8	26.6	10.9	21.2	33.1	46.3
Year	1920	1921	1922	1923	1924	1925	1926
Percentage Landings	60.0	70.3	51.1	57.8	71.2	74.8	89.7

These percentages, together with those for steamers, show that the tendency is for the large vessels engaged in cod-net fishing to base their operations on the port of Buckie.

Large Sail Boats. Just as in the cases of the steamers and large motor boats, the large sail boats engaged in the cod-net fishing landed their catches mainly within the districts of Buckie, Findhorn and Wick. The total number of landings made within these three districts for the whole period was 17,421 and to this aggregate Buckie contributed 49.2 per cent. Findhorn 41.7 per cent. and Wick 9.10 per cent.

In the Banff district the number of landings by large and small sail boats are not specially distinguished in the statistics. Operations were, however, soon limited mainly to the smaller classes of sail boats and on the installation of motors the small motor boat gradually became more popular in the cod-net fishing. In the Cromarty and Helmsdale districts the landings by large sail boats are negligible as the fishery is confined mainly to the smaller craft.

From season 1909 when 1197 landings were effected by the large sail boats there was a rapid increase in activity until the maximum of 2942 landings was reached in season 1912. After that year the importance of the large sail boats gradually waned and in the last season of the war period the number of landings had fallen to 918.

In the post-war period the decline was still more rapid, the numbers falling off from 506 in season 1919 to 21 in season 1926.

The changes which have taken place in each of the three principal districts are shown in the table on p. 170.

The cod-net fishing was started in the Moray Firth by the large sail boats before the advent of motors. At the commencement of the fishery the district of Findhorn took the most prominent position and retained the lead until 1912. There followed a period of continuous decline, the number of landings after 1920 being practically negligible.

Landings by large sail boats at the port of Wick were never numerous. The best pre-war year was season 1912 and after that year a rapid decline set in which was only temporarily arrested during the war period. In the post-war period the total landings amounted to only seventeen; large sail boats engaged in the cod-net fishing have now ceased to land their catches at Wick.

Cod Net Fishing

Number of Landings by Large Sail Boats (1909—1926).

District	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Buckie	291	229	1112	1004	1761	1117	621	508	587	525
Findhorn	851	1104	1241	1662	612	541	372	276	190	272
Wick	55	94	231	276	138	19	128	351	156	121
	1197	1427	2584	2942	2511	1677	1121	1135	933	918

District	1919	1920	1921	1922	1923	1924	1925	1926	
Buckie	393	68	121	65	94	47	15	18	
Findhorn	98	21	4	2	—	—	10	3	
Wick	15	—	1	1	—	—	—	—	
	506	89	126	68	94	47	25	21	= 17,421

The large sail boats were later in taking up cod-net fishing with vigour from the Buckie district and it was not until season 1913 that the largest number of landings in any season was made. From that date onwards, however, Buckie retained first place as the centre for the operations of the large sail boats even although the number of landings in each successive year steadily fell as in the other districts.

It is evident from the table that in the pre-war period there was a tendency for the operations of the large sail boats to become concentrated in the Buckie district in spite of the excellent start which was made in the Findhorn district. The use of large sail boats in the cod-net fishing has persisted longest in the Buckie district although in this locality also these are becoming obsolete.

The decline in the activities of the large sail boats is of course due mainly to the fact that at the beginning of the war period motors were gradually being installed into the boats and these were then re-classified as large motor boats. In the accompanying diagram (fig. 4) the numbers of landings made each year by large sail boats and large motor boats are graphically represented.

The first landings by large motor boats engaged in cod-net fishing were recorded in season 1913; the numbers steadily increased in the following seasons and in 1918 the number of landings by large motor boats equalled those of the large sail boats. In spite of the fact that the average number of landings by a large motor boat engaged throughout the season at the fishing should exceed that of a large sail boat the operations of the large motor boats in the post-war period did not compensate for the declining activities of the sail boats. Indeed in season 1922 there was a marked slackening of effort on the part of the crews of the large motor boats, probably, as already stated, on account of the fact that some of the boats had turned their attention to Danish seine net fishing.

Small Sail and Small Motor Boats. The statistics of landings by small boats are not sufficiently precise and are lacking in the necessary detail, as to the

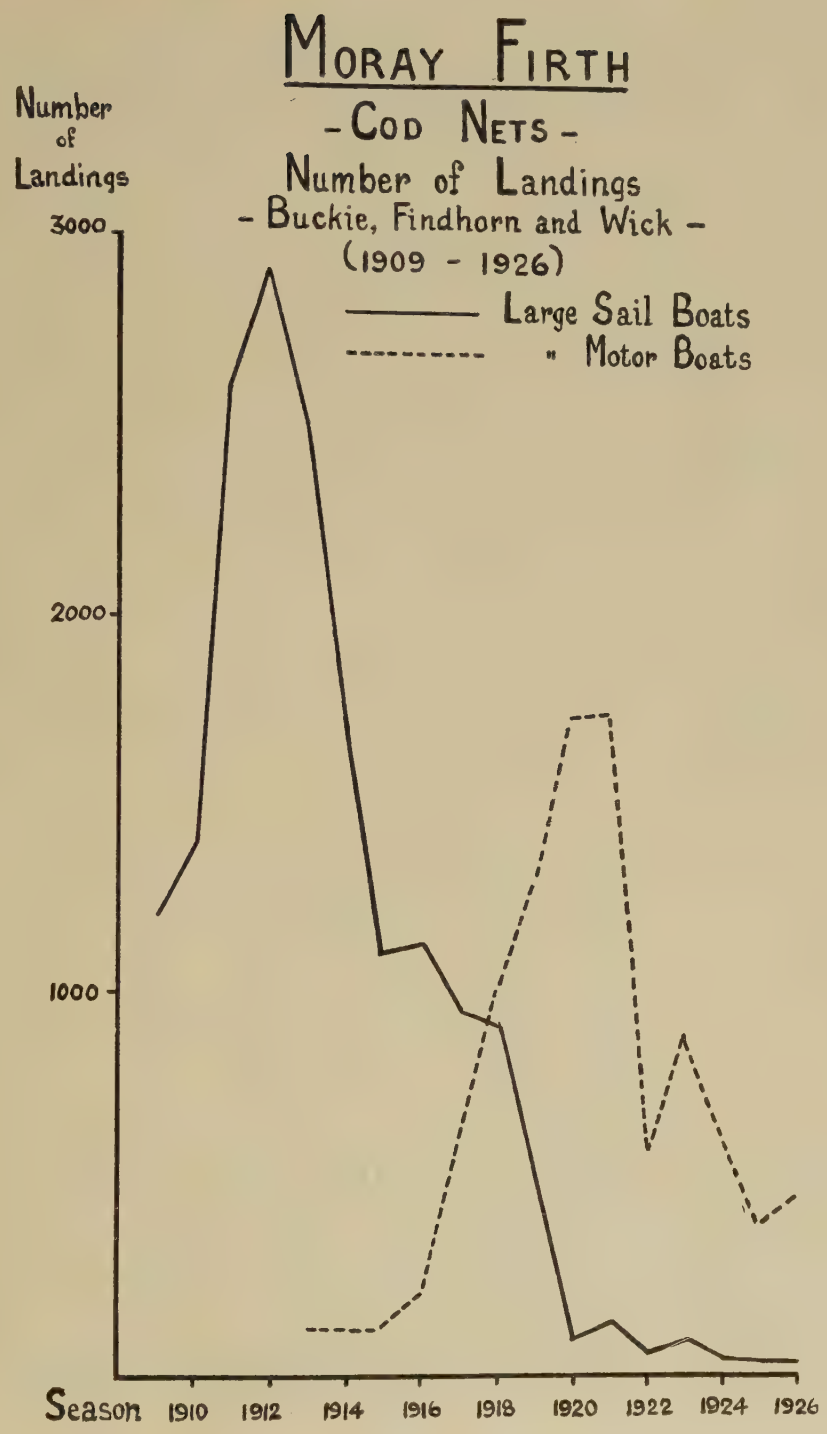

MORAY FIRTH
- COD NETS -
Number of Landings
- Buckie, Findhorn and Wick -
(1909 - 1926)
Large Sail Boats
" Motor Boats
Number of Landings
3000
2000
1000
Season
1910
1912
1914
1916
1918
1920
1922
1924
1926

Fig. 4.

sizes of boats classified under the general term "small". These small boats vary considerably in size and efficiency. Small motor boats were first used in the cod-net fishing in season 1912 and after that date a gradually increasing number of the better class of sail boats had motor engines installed so that the few small sail boats participating in the fishery in the later years of the period were mostly the very small class of craft.

In the Cromarty, Helmsdale and Wick districts the small motor boats set on an average from 25 to 30 nets. In the earlier years before the introduction of motors the small sail boats were equipped with the same number but the smaller class of sail boat which now remains only carries about 20 nets. Along the south shore of the Firth the average number of nets used by the small motor boats is as a rule about 20, but in the Banff district only about 12 nets are carried by these small boats. The better class of small sail boat on the south side of the Firth carries on an average about 12 nets but in the Banff district a number of very small sail boats which still participate in the fishing carry less than half a dozen nets.

Although these small boats generally work within a radius of five or six miles from the port of landing, their operations may be seriously interrupted by adverse weather conditions in these early months of the year and the number of landings per season are therefore subject to considerable variation.

The following are the total seasons' landings by small sail and small motor boats from 1913—1926:—

Cod Nets.

Number of Landings by Small Sail and Small Motor Boats (1913—1926).

Year	1913	1914	1915	1916	1917	1918	1919
Small Sail	3027	1392	1289	1174	1616	337	263
Small Motor	507	1042	1070	1470	997	651	1182
Year	1920	1921	1922	1923	1924	1925	1926
Small Sail	173	437	1062	538	377	436	237
Small Motor	1064	1584	933	772	626	462	266

In the season 1913 the small sail boats effected almost six times as many landings as the small motor boats. The number of landings by small sail boats then rapidly diminished, while those of small motor boats increased. Before 1914 small sail boats for cod net fishing were not favoured at Buckie but from 1921 onwards an average of ten of these small craft were fitted out each season for this type of fishing. In 1922 twenty of these small boats were employed and made 788 landings during the season. It will be noted that after season 1921 a serious decline in the number of landings by small motor boats set in.

The Fluctuations of Cod in the Firth.

As already stated, the cod-net fishery in the Moray Firth is carried on by vessels of many different sizes and types which are classified in the statistical returns according to their methods of propulsion as steamers, motor boats and sail boats. All these vessels, of whatever size and type, use similar nets and adopt the same method of fishing; they may differ from each other with regard to the number of nets employed in the fleet. The fishing efficiency of a vessel is therefore directly proportional to the number of nets used. For each type of vessel using a definite number of nets the number of landings and the average catch per landing are probably the best measures which can be obtained from the data of the intensity of fishing and of the abundance of cod on the grounds frequented by these vessels. Further, by taking into consideration the number of nets employed by each type of vessel, comparable data for all parts of the Firth fished may be obtained. Unfortunately the statistics are lacking in the necessary details for such a comprehensive survey and less satisfactory methods have therefore to be adopted to ascertain the variations in the relative abundance of mature cod from season to season.

Fortunately with regard to the steamers the number of landings and the quantities landed were always distinguished in the statistics. On the other hand the information regarding motor boats and sail boats is much less precise. Although a distinction was made in both cases between the number of landings by large boats and small boats, this distinction was not kept with regard to the quantities landed. The omission is the more unfortunate since there are very marked differences between the efficiencies of the small and large motor and sail boats. In some of the districts, however, large motor and sail boats were employed exclusively, and by selecting the data from those records where no ambiguity is likely to arise, it has been possible to obtain sufficient data to calculate the average catches of each of these types for a number of years.

While comparing the catches of steamers, large motor boats and large sail boats, certain considerations must be kept in view. These large vessels are able to fish when smaller boats are kept in harbour by stormy weather; they use a bigger fleet of nets and can go farther afield to grounds where fish are presumed to be more plentiful. The large power vessels are by far the most efficient; their superiority over the sailing boats is due, just as in the herring fishing, mainly to their ability to make a greater number of trips weekly. They can fish with regularity, have great mobility and are able to land their catches where convenient. The operations of these large vessels cover a wide range and their average catches per season may therefore be taken to represent with a fair measure of accuracy the relative abundance of cod on the offshore grounds in the Firth from season to season.

Steamers carry, as a rule, from 40 to 50 nets and fish mainly off the North-west Coast in the area between Tarbet Ness and Clyth Ness and on the edge of Smith Bank. As has already been mentioned, the Wick fishermen adopted a shorter net after season 1912 but used a larger fleet for which they claim as great fishing efficiency. The number of Wick steamers which carried on cod net fishing is, however, very small and there appears to be no need to make a distinction between them and those belonging to other ports.

Steamers do not begin fishing until the cod have entered the Firth in numbers and they usually cease operations earlier than the smaller boats. It does not appear to be a remunerative proposition for this class of vessel to fish cod nets except at the time of greatest concentration. The average catch per vessel is therefore higher than if the fishing had been carried on over an extended season.

No steamers operated during the war years but there are statistics for at least 13 years in which the landings are sufficiently numerous to give some idea of the abundance of fish in the Firth.

The large motor boats and large sail boats each employ on an average from 35 to 40 nets. With regard to mobility and choice of fishing grounds, the large motor boats are comparable to the steamers.

In the accompanying table the average catches in cwts. per ten landings calculated from the available data are given for these three types of vessels. In addition, the landings of the steamers and large motor boats have been converted into large sail boat units and the means calculated for the combined quantities.

Cod Nets.

Average catch of Cod in cwts. per 10 landings.

	1909	1910	1911	1912	1913	1914	1915	1916	1917
Steamers	421	239	131	256	151	141	—	—	—
Large Motors	—	—	—	—	238	170	226	317	173
Large Sail	229	173	71	144	139	114	194	203	159
Mean Catch p. 10 large sail Boat Units	247	195	79	152	137	114	194	216	161

	1918	1919	1920	1921	1922	1923	1924	1925	1926
Steamers	(131)	197	185	161	279	136	155	152	110
Large Motors	246	194	148	126	203	66	114	151	84
Large Sail	132	141	120	119	—	—	—	—	—
Mean Catch p. 10 large sail Boat Units	174	162	131	115	192	78	107	126	80

Although practically no change took place in any of the three types of vessels as fishing units the calculated values per ten landings can be regarded only as approximate ones for a comparison of the absolute abundance of cod. No correction has been applied to the data for the varying intensities of fishing throughout

the season from year to year. For example it is obvious that the calculated value obtained for steamers in 1918 is too low in view of the fact that the season was almost over before the few vessels which took part in the fishing were fitted out. It is evident from the table (p. 174) and diagram (fig. 5), that in spite of such disturbing factors there is general agreement in the results obtained from these three classes of vessels and one may therefore assume that since these calculated values, obtained by combining the data from different ports of landing, synchronise so closely that they represent more or less faithfully the changes which have taken place in the abundance of mature cod in the offshore waters of the Firth.

The data not only show that there have been great differences in the numbers of cod which entered the Firth but suggest that there have been variations in the disposition of the shoals from season to season. In season 1909 fish appear to have been exceptionally plentiful and well distributed over the area and good catches were secured by the relatively few steamers and sail boats which fitted out for the fishing. Although this was the fourth season in which this method of fishing had been tried, it was only in the Findhorn District that it had become established and consequently the boats from other districts failed to participate to any great extent during this productive season. Many more vessels were fitted out the following season, however, and as mature cod visited the area in considerable numbers the total quantity of cod landed during the season was very high. Then followed the disastrous season of 1911 when cod were extremely scarce and the steamers and large sail vessels were equally unsuccessful in striking shoals of any size. Fortunately the mature cod invaded the Firth in numbers in 1912, and had the steamers been as well prepared as in 1910 the total catch would undoubtedly have been a very large one. The steamers which did take part were slightly more successful than the large sail boats, thus suggesting that the shoals did not penetrate as far into the Firth as in 1910 but that they tended to concentrate on the offshore grounds off the Caithness Coast. With double the number of landings by sail boats but only one fourth of the landings by steamers the total catch of 1912 almost equalled that of the year 1910.

There is no need to describe the other years in detail; the variations from year to year in the average catches are brought out sufficiently clearly in the diagram. Cod were extremely scarce on the offshore grounds of the Firth in seasons 1911, 1923 and 1926, while good catches were obtained on these grounds in seasons 1909, 1910, 1912, 1915, 1916, 1918 and 1922. In season 1909 few steamers were equipped for this method of fishing; after the disastrous season of 1911 the number of steamers which risked the fishing was small; in seasons 1915, 1916 and 1918 most of the vessels were on war service and in 1922 a number diverted their attention to Danish seine net fishing. Thus only in one of the good seasons, namely in 1910, did the steamers obtain full advantage of the presence of large shoals of cod in the Firth during the spawning season.

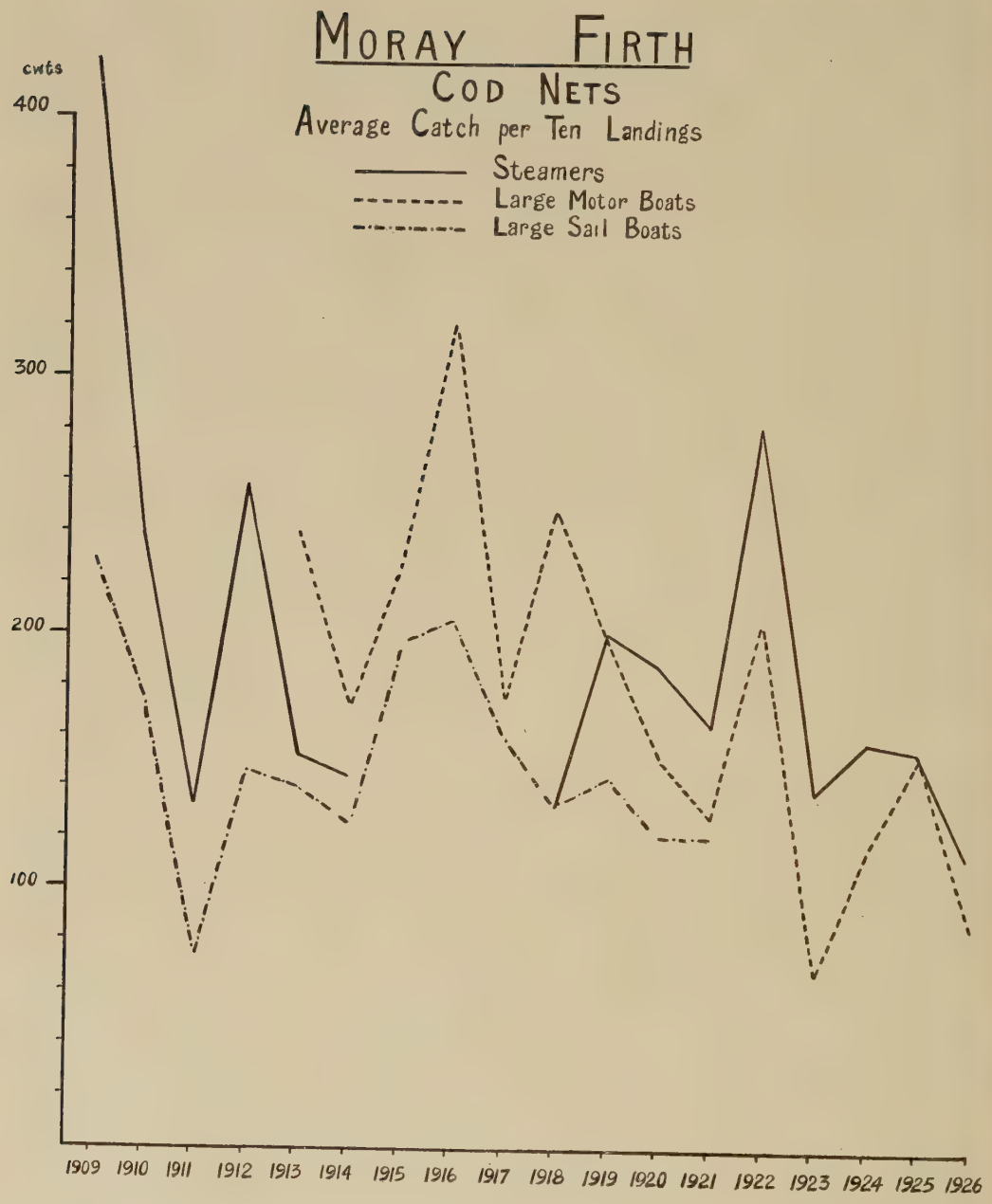


Fig. 5.

In the Cromarty and Helmsdale districts the cod-net fishing is carried on mainly by small boats using about 30 nets which fish in the shallower water in

the near neighbourhood of the coast. Detailed statistics of the landings of these smaller vessels are available from 1916 onwards and these have been combined. The following are the average catches per 10 landings for those boats carrying 30 nets:—

Cromarty and Helmsdale.

Small Sail and Small Motor Boats — Average Catches in cwts. per Ten Landings.

Year	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Average	62	69	97	94	32	42	54	51	42	60	50

These small vessels have a somewhat restricted range of operations and the calculated average values represent only the variations in the abundance of mature cod in the coastal zone from season to season. Further, these small vessels have usually a much more extended season than the larger boats. Even if due allowance is made for the extended season and for the smaller number of nets used, the calculated average landings are lower than those of the larger vessels. The cod appear to be in densest shoals on the offshore grounds. It is also evident from a comparison of the data for the large and small boats that the seasons in which cod are numerous on the inshore grounds do not necessarily coincide with those seasons when they are most abundant offshore.

In conclusion, it may be asserted that while mature cod have failed to visit the Firth in large shoals during the last four seasons, there is no doubt but that judging from the experience of earlier years they will return in due course in greater numbers.

Summary.

There are four phases in the history of the cod-net fishery of the Moray Firth. This method of fishing was first tried in the Firth in 1906. The first three years were experimental years when it was tried tentatively from various ports. The district of Findhorn played a leading part in the initial stages of development of the fishery. The method soon became part of the normal routine of the fisheries of the Firth. The fishing, which was well established by the year 1909, was carried on mainly by large sail boats and steamers. Good catches were obtained from the dense shoals of cod which invaded the area in 1909 and in consequence a larger number of boats was fitted out in the following season. Cod were again plentiful and the aggregate catch was the highest obtained for the whole period. Season 1911 was a disastrous one, however, and in the following year fewer steamers risked fitting out for the fishery, although the fish entered the area in that season in considerable numbers. The erratic behaviour of the cod appears to have made the fishery less attractive to the steamers than to the smaller vessels. The steamers do not appear to have recovered completely from the disastrous season of

1911, for their return to the fishery has been slow. During the pre-war period the activities of the Findhorn District gradually declined and Buckie became the landing centre.

Then followed the war years when most of the steamers were on war service. The aggregate yearly landings dropped suddenly to half of those of the pre-war years and the prices per cwt. rapidly rose to an unprecedented height. At this period the motor boat began to play an increasingly important rôle and motors were installed into the large sail boats and into many of the better class of smaller sailing boats.

After the war the large sail boat was gradually eliminated probably by the introduction of motor power into most of the vessels but a few still lingered in the Buckie district and carried on cod-net fishing in the season. After the war the steamers gradually returned and their activities increased but only a relatively small proportion of them participated in the cod-net fishery. The most marked feature in the development of the fishery in the last few years, however, has been the concentration of the larger boats in the Buckie district. It is from this district that the fishery is now carried on with greatest vigour, the large vessels crossing to the north-west shore of the Firth to set their nets.

The activities of the smaller boats which work from the creeks all round the coast are confined to the nearer waters in close proximity to the coast. Most of the small vessels are furnished with motors.

With the introduction of the Danish seine net in 1921 a number of the large power vessels adopted this method of fishing. The innovation is of too recent date to determine whether it will supplant entirely the older method.

There have been considerable variations from year to year, not only in the abundance of mature cod in the Firth, but in the loci of concentration of the spawning shoals; in some years the shoals advance further into the Firth and to the coastal zone. There has been a progressive decline in the abundance of the species in the Firth during the last few years. This downward tendency received a slight check in the season 1922. The erratic behaviour of the cod in earlier years leads one to expect that the spawning shoals will again seek the precincts of the Firth in greater numbers.

Paper No. 9.

Danish Seine Net Fishing in the Moray Firth

by

A. Bowman, D. Sc.

Introduction of the Method to Scottish Waters.

The method of fishing by means of the Danish seine net was first introduced into Scottish waters in the autumn of 1921, its adoption by a number of vessels at that time being undoubtedly accelerated by the prevailing economic conditions. In that year a large number of Danish motor boats using this net landed good catches at English ports during the coal strike and even after bunkers became available for trawlers these small vessels proved able to compete successfully in the market. The Danish net was therefore rapidly adopted at first by English vessels and almost immediately thereafter by a number of Scottish steam drifters and motor boats.

The introduction of mechanical propulsion into the herring fishing fleet has brought its own peculiar responsibilities. Those power vessels must be kept in almost constant commission to meet expenses; they cannot be laid up with the same facility as the older sail boats. The light Danish seine net is specially suitable for operation by the vessels normally employed in the Scottish drift net fishing and these can readily be converted for this fishing at comparatively small expense. The introduction of this method for catching demersal species synchronising with a time of acute depression in the herring fishing industry, a number of drift net fishermen were induced to give the method a trial. Steam and motor drifters from Moray Firth ports were equipped with the new gear and fishing was soon being carried on energetically in local waters.

The Fishing Grounds.

Grounds suitable for Danish seine net fishing are of limited extent in Scottish waters. Only on grounds where the bottom is smooth and free from all obstacles can the method be used with success; many of the grounds which can be fished with facility by the trawler are wholly unsuitable for seine net fishing. Fishing operations can, as a rule, only be carried on during the daylight hours and are sub-

ject to more frequent interruptions by weather conditions than trawling. So too the selection of grounds is limited by such practical considerations as the distance of these from the home ports and the nature of the remuneration yielded by the catches.

The most favoured area in Scottish waters is the Moray Firth and here fishing is carried on with greatest intensity from December to March. When catches become less remunerative some of the vessels continuing the fishing proceed to the southern grounds, while others try various areas off the Scottish coast, such as Berwick Bank, Bell Rock area, Aberdeenshire coast, off Kinnaird Head, north of Scotland etc. The Moray Firth is again resorted to, however, in the summer and autumn months, more particularly when there are indications of the incursions of hake into that area.

With regard to the Moray Firth the general nature of the bottom is indicated on the chart given in Paper No. 2 (p. 41). Fishing cannot be carried on with equal facility in all parts of the Firth on account of the rough and unsuitable nature of the bottom in many places, although no doubt intimate knowledge not only gives the local fishermen a wider choice of grounds but is also of value in preventing excessive damage of gear.

In the years prior to and since the introduction of this method of fishing large numbers of marked plaice and lemon soles, the two species of greatest importance for the fishing, were liberated in different localities and at different seasons within the precincts of the Firth. The records of recapture of the marked fish therefore provide very definite information as to the most favoured fishing grounds within the Firth and the places of recapture are recorded on the accompanying chart (p. 181). It will be noted that most of the captures have been made within the 30-fathom contour line of depth. Both species are found generally distributed within this depth line but there is a very marked difference between the positions of the centres of density; plaice are caught in largest numbers in the inner parts of the Firth, while the centres of density for lemon soles lie off Clyth Ness on the north-west coast and off Banff on the south coast.

The fishing is prosecuted mostly by fishermen of the Fraserburgh, Banff, Buckie and Findhorn districts and the men of each of these districts exhibit more or less distinct preferences as to grounds. Those of the Findhorn district fishing from and landing their catches at the port of Lossiemouth frequent the ground $3^1/_2$ to 8 miles off the coast between Lossiemouth and Burghead. They also extend their operations in the direction of Tarbet Ness and from Tarbet Ness to Noss Head. While the vessels from the Buckie district operate on the same grounds as those frequented by the vessels of Findhorn district, the productive grounds lying between Dunbeath and Noss Head are those most intensively fished. The larger vessels fishing from the Banff district also frequent the grounds off the north-west coast. A small but very productive area lying just outside the territorial limit off

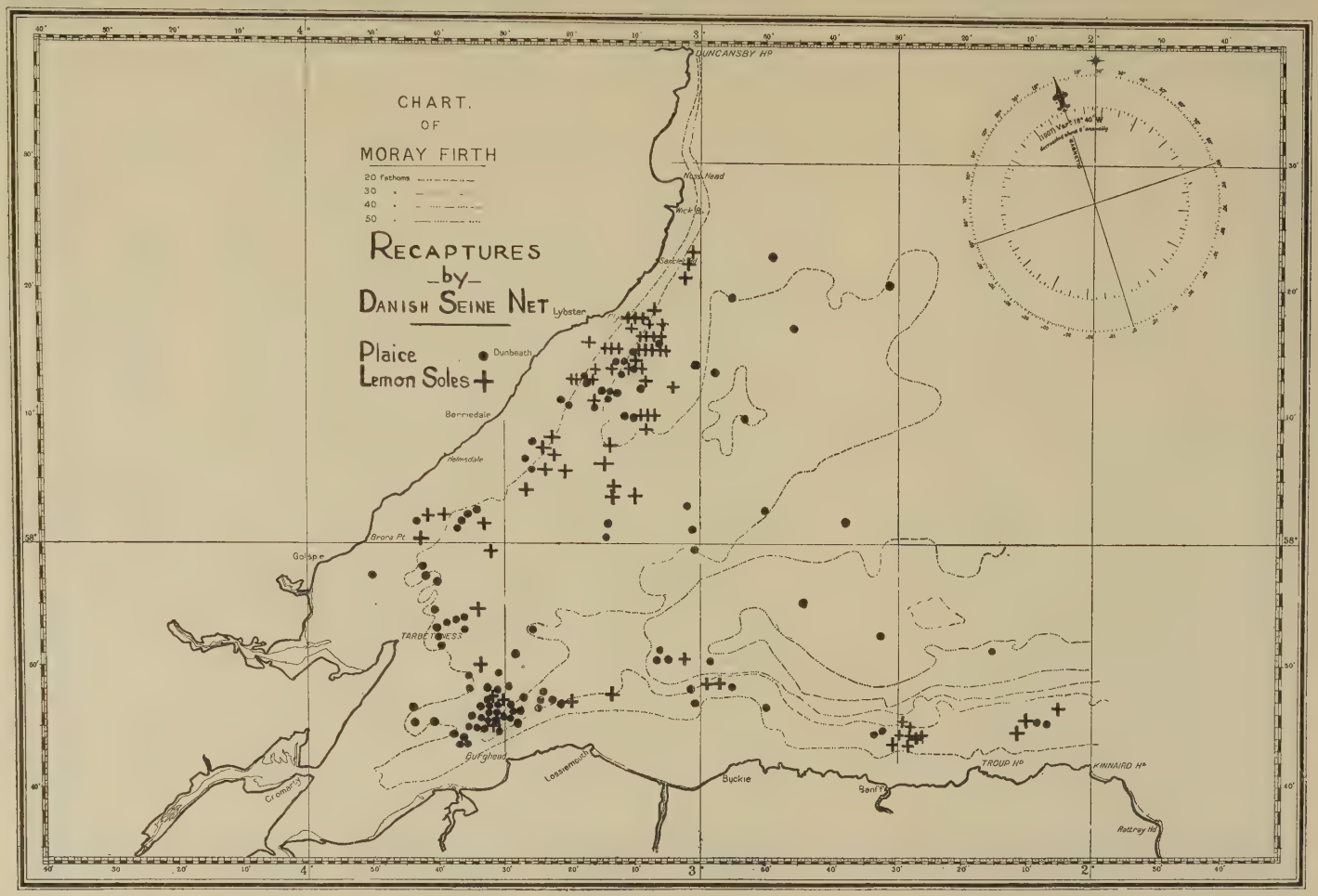

PLAICE and LEMON SOLES
Recaptured
CHART.
OF
MORAY FIRTH
20 Fathoms
30 "
40 "
50 "
RECAPTURES
-by-
DANISH SEINE NET
Plaice
Lemon Soles +
DUNCANSBY HD
Noss Head
Wick
Lybster
Dunbeath
Berriedale
Helmsdale
Brora Pt
Golspie
TARBET NESS
Gutghead
Lossiemouth
Cromarty
Buckie
Banff
TROUP Hd
PINNAIRD Hd
Rattray Hd

Fig. 1.

the Banffshire coast is frequented in season by the smaller types of motor craft of the district. The area thus fished extends from Rosehearty in the east to Knock Hill in the west. It is also the proximity of this very productive area to Fraserburgh which maintained the fishery from that port.

The Witch (*Pleuronectes cynoglossus*), found in numbers in the deeper area beyond the limits of the Firth, extends its distribution into the area along the deep southern muddy gully penetrating as far west as Burghead and it is here or in close proximity thereto that Witches are fished chiefly in the months of March, April and May. The vessels based on Fraserburgh also operate further eastwards beyond the limits of the Firth in their search for this species. On the other hand the best catches of hake are obtained in the north-western valley during the summer months.

The Data.

Since the introduction of the Danish seine net detailed statistics have been kept as to the number of landings by steamers and motor boats and as to the weights and values of the species caught. During the year 1926 the number of days' absence of each vessel was also included in the data.

The catches made within the limits of the Moray Firth have been separately distinguished and in the appended tables are given the monthly data for each of the complete years of all fish taken from the Moray Firth at whatever port landed. Only the important economic species have been separately enumerated.

Practically all the catches landed at the various Firth ports are taken within the area. A number of the vessels, however, prefer to land their catches at Aberdeen and particulars of these have been extracted and so separated from the shots drawn from other fishing grounds. Most of the catches taken by Scottish vessels from the North Sea beyond the limits of the Firth were also landed at Aberdeen. This fishing was carried on almost exclusively by vessels belonging to Moray Firth ports and for the sake of comparison the yearly totals landed at Aberdeen by these vessels are added. The data therefore include practically all Danish seine net landings made at Scottish ports with the exception of those of small motor boats of under 40 feet keel which are permitted to fish within certain territorial waters.

The Number of Landings.

The number of landings made within each district for the years 1922—1926 (incl.) are given in the accompanying table; landings made at Aberdeen by vessels fishing in other areas are also shown for comparison but not included in the totals.

Moray Firth.

Danish Seine Net 1922—1926. — District Landings.

	1922		1923		1924		1925		1926		Total	
	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor
Aberdeen M. F.	55	7	113	2	255	1	76	—	94	2	593	12
(outside M.F.)	(343)	(3)	(562)	(1)	(453)	(18)	(172)	(25)	(46)	(—)	(1576)	(47)
Fraserburgh ..	—	39	26	565	33	665	224	777	221	884	504	2930
Banff.....	198	202	209	529	275	1899	370	1663	318	2208	1370	6501
Buckie.....	898	167	272	119	220	37	140	30	117	33	1647	386
Findhorn.....	992	50	1159	167	912	222	866	190	1025	307	4954	936
Wick	—	1	1	—	—	—	1	2	11	1	13	4
Total...	2143	466	1780	1382	1695	2824	1677	2662	1786	3435	9081	10769

Steamers.

A number of steamers were equipped in the autumn of 1921 and most of them continued the fishing throughout the following year. The intensity of fishing which characterised these early operations in home waters was not maintained and in 1923, the second complete year in which the method was tried, the total landings fell short of those of the previous year. The relatively heavy working expenses of the steamers, the decline of the catches in local waters after the spring months and the continuance of the adverse conditions in the herring fishery soon caused a number of the crews to seek more profitable grounds and each year has seen some of the steamers continuing the fishing throughout the summer from English ports, landing catches there from the Fisher and Dogger Bank areas, but making occasional landings at Aberdeen when en route to spend a week-end at their home ports. In spite of the transfer of the operations of a number of the steamers to southern grounds the number of landings from the Moray Firth in the following three years (1924—1926) showed no sign of further decline.

Lossiemouth was the principal port of landing for steamers fishing in the Firth. The method was adopted early by the steamers and during the five years the fishery has been in existence over 54 per cent. of the total landings by steamers were made at this port. There were changes in the seasonal incidence but there was no marked falling off in the number of landings at this port.

The steamers made an equally good start at Buckie and contributed 42 per cent. of the landings in 1922. Apparently results were not sufficiently attractive to induce the Buckie steamers to continue fishing in the Firth with the same degree of intensity and the number of landings fell rapidly from 898 in 1922 to 117 in 1926. The decline is due probably not so much to the discontinuance of the fishing

as to the fact that at an early date a number of the Buckie steamers turned their attention to fishing on the Dogger and Fisher Banks.

Danish seine net fishing by steamers does not appear to have been favoured in the Wick district but at Banff and Fraserburgh the number of landings made has increased each successive year.

Most of the landings at Aberdeen were made by steamers belonging to Moray Firth ports but the bulk of the fish was caught in areas outside the Moray Firth.

Motor Boats.

The history of the development of Danish seine net fishing by motor boats in the Moray Firth, although short, is interesting. Motors had been installed in most of the better sail boats during the war or immediately after but no new motor boats have been built specially for participation in this fishery. Its growth has been accomplished by the adaptation of the existing craft. In each district the seine net fishing has had to compete with established methods and its growth has therefore depended on the suitability of the vessels at the ports and the proximity of profitable fishing grounds. Some fishermen appear to have a preference for Danish seine net fishing finding it less laborious than small line fishing.

Although a few motor boats were equipped with the net in 1921 these craft were as a rule later than the steamers in taking to the fishery. Every year, however, has seen an increase in the number of landings. Fishing on the offshore grounds is carried on by boats of 50—60 feet keel. The adoption of the method has, however, been most thorough in the Banff district where the smaller type of motor boat of 30 to 40 feet keel is found to be well adapted for fishing on the grounds in the vicinity of the port of landing.

Here seine net fishing is carried on most intensively in the early months of the year and owing to the nearness of the fishing grounds landings are effected practically daily. At Fraserburgh the motor boat is more favoured than the steamer and although the fishing is not carried on so intensively as at Banff the number of landings has also steadily increased. The adoption of the motor boat has been much slower in the Findhorn district and while the number of landings has increased yearly they have not so far exceeded those of the steamers. The fishermen of the Buckie district do not appear to regard this type of vessel with great favour for Danish seine net fishing and although 167 landings were made at Buckie by motor boats in 1922 the number had fallen to 33 in 1926. Aberdeen is not used by motor boats as a base for seine net fishing in the Moray Firth.

The seasonal Landings.

Danish Seine Net. — Seasonal Intensity of Fishing.

Year	Percentages of Landings						Total Landings	
	Jan. to April		May to Aug.		Septbr. to Dec.			
	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor
1922.....	66.6	76.4	11.9	11.2	21.5	12.4	2143	466
1923.....	48.1	52.6	11.2	15.7	40.7	31.7	1780	1382
1924.....	55.8	58.6	35.1	21.7	9.1	19.7	1695	2824
1925.....	77.8	68.2	12.1	18.4	10.1	13.4	1677	2662
1926.....	79.4	77.8	4.9	8.1	15.7	14.1	1786	3435
1922—1926...	65.5	67.0	14.8	15.4	19.7	17.6	9081	10769

Each year the fishing was carried on with greatest intensity both by steamers and motor boats in the early part of the year. During the five year period (1922—1926) over 65 per cent. of the landings was made in the first four months. The following are the monthly percentages of landings for the whole period.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Steamers.....	15.5	19.4	20.8	9.8	4.9	2.4	2.8	4.7	6.6	5.6	3.5	4.0	9081
Motor Boats	16.4	15.3	20.3	15.0	6.1	3.7	3.7	1.9	2.8	3.6	2.8	8.4	10769

Most of the steamers ceased operations in the Firth after the month of April but the motor boats continued somewhat longer. While the percentages of landings by steamers increased in the autumn months reference to the previous table shows that this feature is to be ascribed mainly to their activities in the autumn months of the years 1922 and 1923. These were seasons when the prospects in the herring fishery were very black. The changes which took place in the seasonal incidence of the fishing in the various districts show that the tendency to restrict operations in the Firth to the early months was general. Fishing in the Firth after the month of April does not appear to be a remunerative proposition for the steamers unless large shoals of hake appear in the area in the summer months. This happened in the year 1924 when 35 per cent. of the landings for that year were made during the four months May to August. The significance of the changes which have taken place in the fishery since its inception can perhaps be better appreciated from a consideration of the District landings and the variations in the seasonal incidence of the fishing in the different districts may be discussed briefly by reference to the percentages of the landings made in the first four months of the year. The total district landings by steam and motor boats for each year are given on page. 183.

Steamers.

The following are the percentages of landings made by steamers within the different districts during the first four months January to April.

Fraserburgh	Banff	Buckie	Findhorn	Aberdeen
76.9	95.3	65.9	60.4	29.0

From the beginning of the fishery the steamers fishing from the Fraserburgh and Banff districts confined their operations in the Firth to five months of the year. This seasonal fishing began as early as December, but was usually over by the end of April; January, February and March being the most important months. Some fishing in the outer limits of the Firth was carried on from Fraserburgh in May and even June. At Buckie there was the same tendency for the fishing to be restricted to the early months of the year. In 1926 all landings except five were effected in the first four months of the year. In the first three years of the fishery, however, a number of the steamers continued fishing in the Firth throughout the year probably on account of the poor prospects in the herring fishing. Fishing grounds beyond the limits of the Firth were not so generally known to the Moray Firth fishermen in those years. In the Findhorn district, where the fishing was carried on most energetically, landings were more general throughout the whole year, although with a distinct falling off during the summer months. The data of the monthly landings show that in this district there was also a tendency during the last two years for the intensity of fishing to increase in relative importance in the first four months.

Aberdeen was not a permanent base from which steamers conducted seine net operations. Steamers as a rule only visited Aberdeen intermittently, those fishing in the Moray Firth landing at that port in the expectation of realising better prices for their catches, those fishing in southern waters landing occasional catches when on a week-end visit home. The relation of Aberdeen to the Moray Firth area was somewhat different to that of other ports and this is borne out by the seasonal incidence of the landings from that area. Of the total landings from the Moray Firth made at Aberdeen only 29 per cent. were attributed to the first four months of the year, but almost 53 per cent. were made in the three months July, August and September. In other words, good catches of hake taken in the Moray Firth are mostly landed at Aberdeen. It is to be noted further that the heaviest landings during these three months were made in 1924, the year when hake appeared to be most numerous in the Firth.

Motor Boats.

The following are the percentages of landings made by motor boats in each district during the four months January to April.

Fraserburgh	Banff	Buckie	Findhorn
57.6	76.8	52.2	37.9

If the percentages are compared with the corresponding figures for steamers it will be observed that although the motor boats also fished most intensively in the Firth in the first four months of the year this feature was not so pronounced as in the case of the steamers. There was a greater tendency to prolong the season in all probability owing to the smaller working expenses of the motor boat. Indeed the motor boats working from Lossiemouth carried on their operations very regularly throughout the whole year. The port of Lossiemouth is furthest away from the regular summer herring fishing grounds and it would therefore appear as if the boats engaged in seine net fishing preferred to continue the fishing at home rather than fit out in summer for the comparatively short herring fishing season.

Danish seine net fishing with motor boats has not proved a success at Buckie. Thirteen vessels were fitted out in 1922 but as the results were disappointing only seven participated in the fishing in the following year. The fishing was not carried on energetically in either of these years although operations extended over the whole year. In 1924 the fishing fell away and only two motor boats shared in the landings. During the last three years only 100 landings have been made by motor boats at Buckie and all these with the exception of two were made from January to May.

Motor boats have been most successful in the Banff district. In the first two years their operations were confined to the first four months of the year when plaice and lemon soles made up practically the entire catch. In the last three years, however, a number of boats continued the fishing throughout the whole year.

Although the fishing was carried on from Fraserburgh with greatest intensity during the first four months of the year there was a tendency for the motor boats to continue operations until late in June and even into July. During the first four months of the year catches consisted chiefly of plaice and lemon soles caught on the grounds about $3^1/_2$ miles off Aberdour Bay. As the catches declined in the latter part of April the fishing was conducted further offshore for witches, and in the years when hake were plentiful in the Firth this species became the object of the fishery in the summer months. From July to November, however, most of the crews were engaged at herring fishing and seine net operations were not resumed until about the middle of December, although in the autumn months of 1923 and 1924 a few boats continued the seine net fishing.

The Yearly Landings.

The following summary of the more detailed statistics of fish caught by Danish seine net in the Moray Firth (p. 188) gives the numbers of landings and the total quantities and values of all fish landed by steamers and motor boats in each complete year:—

Danish Seine Net.

Total Weights and Values of Fish landed yearly 1922—1926.

Year	Steamers.			Motors.		
	Number of Landings	Cwts.	£	Number of Landings	Cwts.	£
1922.....	2143	28062	66446	446	2825	6755
1923.....	1780	25823	57662	1382	8022	16721
1924.....	1695	39956	74772	2824	12066	27750
1925.....	1677	18844	49659	2662	9384	22094
1926.....	1786	19989	45737	3435	8981	24157
1922—1926...	9081	132674	294276	10769	41278	97477

The motor boats with a much smaller average catch per landing than the steamers have gradually taken a bigger share in the seine net fishing in the Firth. In the first complete year of the fishery they contributed only 9 per cent. of the total weight of fish caught but in 1926 their share had increased to 31 per cent.

The best year for both steamers and motor boats was 1924. In that year the steamers with fewer landings had improved on their previous year's results by fifty per cent. There was a similar improvement in the weight and value of the fish landed by motor boats but they only attained this result with double the number of landings of the previous year. The steamers were relatively more successful than the motor boats and it is to be noted that in that year over 35 per cent. of the steamer landings was made during the summer months. The success achieved by the steamers in 1924 was not repeated during the next two years and with no appreciable falling off in the number of their landings the total quantity of fish brought to market in each of these years was less than half of that landed in 1924. There was a somewhat similar decline in the total quantities of fish caught by motor boats in the years 1925 and 1926. In the last year, for 3435 motor boat landings, the total weight of fish amounted to only 8981 cwts.

Landings may consist of mixed catches of the commonly occurring forms, relatively small catches of the more valuable species or large catches of the less valuable ones.

Danish Seine Net.

Mean Value in £'s sterling per 100 cwts.

	1922	1923	1924	1925	1926
Steamers.....	236	*223*	187	*264*	229
Motor Boats	239	208	*230*	235	*269*

In the years 1923 and 1925 the steamer catches had a relatively higher proportion of the more valuable forms than the motor boats, while in 1924 and 1926 the motor boats caught a greater proportion of these than the steamers.

In the successful year of 1924 the steamers secured relatively large catches of the less valuable species.

In comparing the steamer and motor boat catches due regard must be given to the locus of the fishing ground and the seasonal incidence of the fishing.

The Species Caught.

Twenty-three species are recorded in the Danish seine net catches from the Moray Firth. Many of these are not sufficiently numerous or not sufficiently valuable to be of importance for the fishery. Only the seven most important species are taken into consideration and the total weights and values of these caught during the period 1922—1926 (incl.) are given in the following list arranged in order of value:—

Danish Seine Net.
Species Caught 1922—1926.

Value		Species	Weight	
Percentage Contribution	£s.		Cwts.	Percentage Contribution
35.2	137517	Plaice (*Pl. platessa*)	35029	20.1
30.4	119120	Lemon Sole (*Pl. microcephalus*)	25330	14.6
12.3	48240	Haddock (*G. aeglefinus*)	41324	23.8
7.2	28226	Witch (*Pl. cynoglossus*)	12248	7.0
6.7	26120	Hake (*M. merluccius*)	23117	13.3
4.4	17416	Cod (*G. calarias*)	17189	9.9
1.2	4571	Skate (*Raia* spp.)	8331	4.8
	10543	Others	11384	

Included amongst the other species are Monk (*Lophius piscatorius*), Megrim (*Zeugopterus megastoma*), Halibut (*Hippoglossus vulgaris*), Brill (*Rhombus laevis*) and Whiting (*G. merlangus*), each contributing over £1000 in value. Such species as Turbot (*Rhombus maximus*), Catfish (*Anarrhichas lupus*), Dabs (*Pleuronectes limanda*), Ling (*Molva molva*) etc. contributed quantities of comparatively small value.

The following are the mean values per 100 cwts. of the seven species which made up the bulk of the catches:—

Species	Average value pr. 100 cwts.
Lemon Sole	£ 470
Plaice	393
Witch	230
Haddock	117
Hake	113
Cod	101
Skate	55

The Lemon Sole is the most valuable species but as it was caught in smaller quantities than the Plaice it ranks only second with regard to total value. The haddock, contributing the greatest weight, was third with regard to total value. Plaice, Lemon Sole and Haddock taken together contributed over 58 per cent. by weight and 78 per cent. by value of all fish taken from the Firth by Danish seine net.

As has already been stated, there were differences between the composition of the catches of the steamers and motor boats.

Percentage Contributions to the Total Catches 1922—1926.

	By Weight		By Value	
	Steam	Motor	Steam	Motor
Plaice	23.1	10.5	41.0	17.4
Lemon Sole	11.6	24.0	24.5	48.3
Haddock	24.0	23.1	12.9	10.5
Hake	13.0	14.1	6.7	6.5
Witch	5.6	11.8	5.8	12.0
Cod	11.6	4.5	5.3	1.9

The order of value of the species in the steamer and motor boat catches is not the same. In the steamer catches the plaice was by far the most important, contributing 41 per cent. of the total value, whereas in the motor boat catches the lemon sole took the lead with a contribution to the total value of over 48 per cent. For the separate years these relations hold even although the percentage value of the plaice in the steamer catches varied from 28.3 to 52.1 and the percentage contribution of the lemon sole in the motor boat catches varied from 26.6 to 65.1. In other words, the steamers fished mainly on the plaice grounds when fishing for flatfish, a few lemon soles being caught during these operations, while the motor boats frequented those grounds where lemon soles were most abundant.

While plaice and lemon soles were the main objects of the fishery, their percentage contributions to the total catches depended on the relative abundance of the other species. When the plaice contributions were high the lemon sole contributions were as a rule also high and *vice versa*. On the other hand the haddock, hake and witch did not show any such relation although when taken together they stand in inverse relationship to the two valuable flatfish. In short, when the catches of plaice and lemon soles declined the steamers and motor boats gave greater attention to the capture of the other three species. The hake was practically absent from the catches in the year 1922 and poorly represented in those of 1926; its best year in the steamer landings was 1924 when it contributed over 17 per cent. of the total value while it was most abundant in the motor boat catches in the following year, contributing over 10 per cent. of the value. The best year for haddock for the steamers was 1924 when the value of the catch reached 21 per cent.

of the value of all fish landed but it was in 1923 when the species, contributing 17.4 per cent. of the total value, was most prominent in the motor boat landings. Witches did not add largely to the steamer catches although in 1922 the catch reached 14.4 per cent. of the value of all fish landed, but in the motor boat returns they were much more in evidence and contributed 31 per cent. of the value landed in 1923.

The Percentage Contributions by the different Species to the Seasonal Catches.

The six species — plaice, lemon sole, haddock, hake, witch and cod — contributed together over 96 per cent. of the total value of the catches of both the steamers and motor boats and at no season of the year did their combined value fall below 90 per cent. Other species occurred sporadically in the catches but were never sufficiently numerous to have any appreciable effects on fishing operations. The varying abundance of the six important species on the different fishing grounds, however, not only had considerable influence on the composition of the catches but determined largely the course of the fishing throughout the year. Value of the catch, not weight, is, however, the factor determining the selection of the fishing ground and therefore the composition of the catches. The seasonal nature of these changes in the catches is summarised in the following tables and illustrated by the diagrams showing the percentage values of the six important species in the catches. A diagram showing the seasonal changes in the percentage composition of the catches by weight is also given for comparison. These percentage numbers show only the approximate relative abundance of the species in the catches at different seasons of the year and provide no information as to their absolute abundance in the Firth.

Danish Seine Net — Steamers.
Mean monthly percentage contributions to the catches (1922—1926)
Value.

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plaice	54.4	54.5	48.4	37.0	26.8	17.6	14.8	15.6	28.3	40.2	51.8	50.3
Lemon Sole	29.6	26.6	29.7	31.3	33.0	15.7	11.0	15.7	16.1	14.7	11.5	30.8
Witch	3.1	3.3	5.9	13.7	12.2	12.3	4.8	6.2	3.9	4.4	3.6	2.3
Haddock	5.8	3.9	3.5	5.4	15.5	25.6	15.6	31.2	30.8	33.4	24.2	9.7
Hake	0.0	0.0	0.1	0.0	1.0	21.4	48.6	26.1	16.0	1.0	0.2	0.1
Cod	4.2	8.4	9.3	5.0	4.0	3.3	2.5	2.5	1.9	2.3	3.3	2.8
Total...	97.1	96.7	96.9	92.4	92.5	95.9	97.3	97.3	97.0	96.0	94.6	96.0

Danish Seine Net — Motor Boats.
Mean monthly percentage contributions to the catches (1922—1926).
Value.

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plaice	25.6	19.6	12.6	14.2	11.7	5.4	15.3	28.9	16.7	16.1	24.3	22.9
Lemon Sole	67.2	69.8	74.5	53.2	26.2	6.4	9.1	14.0	14.6	9.4	8.4	62.0
Witch	1.8	2.6	7.0	16.4	30.9	21.0	13.0	21.6	26.1	15.2	19.6	4.6
Haddock	3.0	3.9	2.7	4.9	9.3	11.2	20.6	23.5	31.7	48.5	37.9	8.0
Hake	—	0.2	0.1	0.2	6.0	49.6	36.9	7.4	5.8	1.5	0.4	—
Cod	1.0	2.3	0.9	2.3	3.0	3.2	2.2	2.4	1.9	2.5	2.1	0.9
Total...	98.6	98.4	97.8	91.2	87.1	96.8	97.1	97.8	96.8	93.2	92.7	98.4

Steamers.

At all times of the year the plaice was an important constituent of the steamers' catches and for five months of the year (November to March) the weight caught realised not less than half of the gross total value. Only in the months of June, July and August did the value of the species fall below 20 per cent. It is therefore obvious that for at least six months of the year the distribution of the plaice in the Firth determined in great measure the fishing grounds selected by the steamers.

The lemon sole supplying one quarter of the value of the steamer catches was the species next in importance to the plaice, its relative value being greatest in the first and second quarters of the year. If the contributions made by plaice and lemon soles throughout the year are compared, it is to be noted that while the relative importance of plaice in the catches began to decline in March, the percentage value of the lemon sole remained comparatively high until the month of May and that the combined value of these two species exceeded that of the rest of the catch for eight months of the year.

Plaice and Lemon Sole.
Mean Monthly Percentage Values. Steamers.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
84.0	81.1	78.1	68.3	59.8	33.3	25.8	31.3	44.4	54.9	63.3	81.1

During the four months December to March the combined value of these two species exceeded 75 per cent. of the value of the total catch and only during the four months June to September did it fall below 50 per cent.

The intrinsic value of the witch is much less than that of either the lemon sole or plaice. The Witch is not found commonly on the grounds frequented by the other two species but is most abundant within the Moray Firth on the deeper and

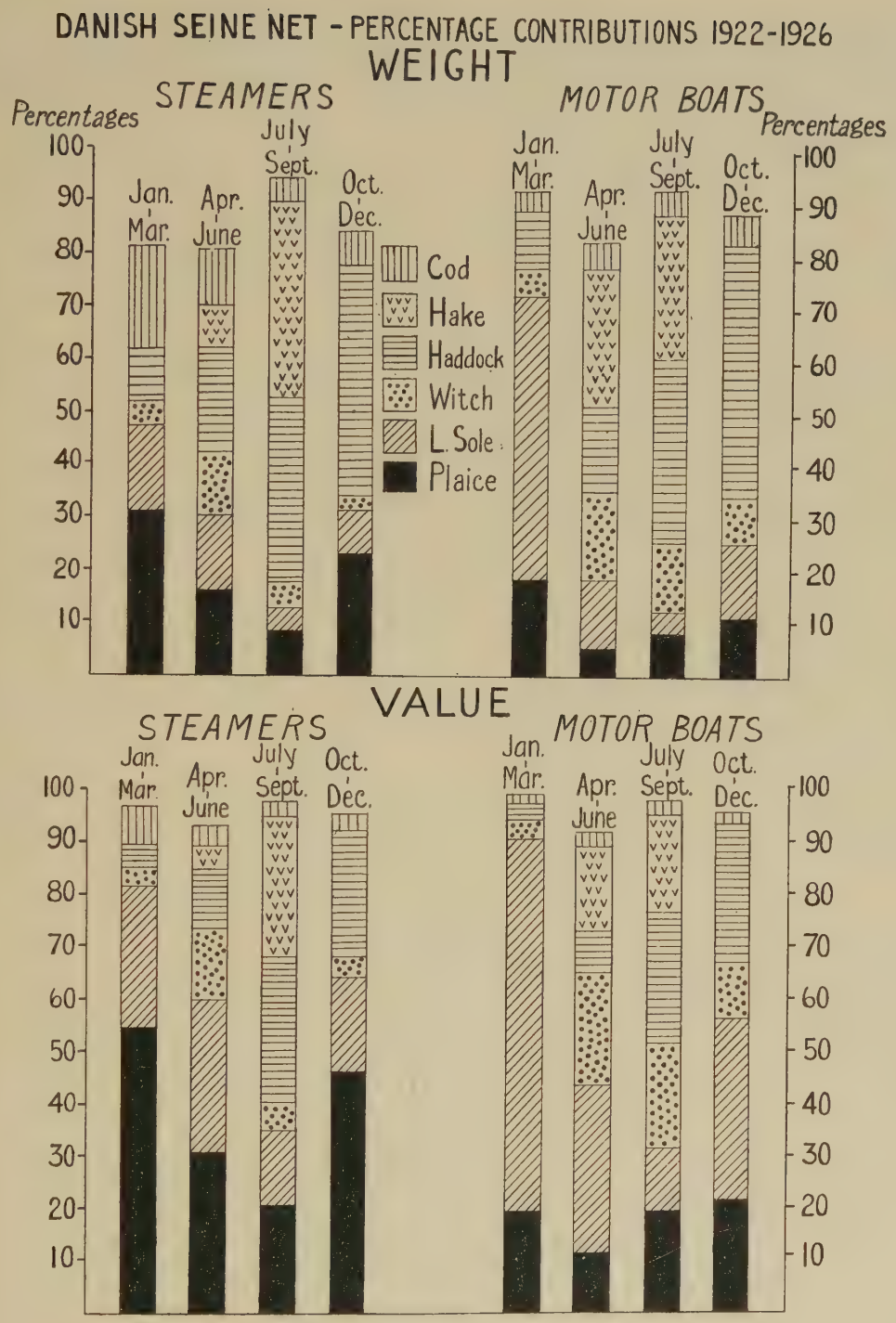

DANISH SEINE NET - PERCENTAGE CONTRIBUTIONS 1922-1926
WEIGHT
STEAMERS
MOTOR BOATS
Percentages
Percentages
Jan. Mar.
Apr. June
July Sept.
Oct. Dec.
Cod
Hake
Haddock
Witch
L. Sole
Plaice
VALUE
STEAMERS
MOTOR BOATS

Fig. 2.

muddier grounds. The share contributed by the witch to the catches was therefore small during the period of the year when the two more valuable species were the main object of the fishing, but its relative value increased in the months of April, May and June when the contributions made by the plaice and lemon soles were decreasing.

Plaice, Lemon Sole and Witch.

Mean Monthly Percentage Values. Steamers.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
87.1	84.4	84.0	82.0	72.0	45.6	30.6	37.5	48.3	58.3	69.9	63.4

At the end of the plaice spawning season the steamers gradually changed their fishing grounds to the areas where witches were more abundant. The three species of flatfish together contributed by far the greater share of the value of the steamer catches during eight months of the year.

Unlike the plaice and lemon sole, the relative importance of the haddock was greatest in the three months August, September and October when its mean percentage contribution exceeded 30 per cent. of the total value of the fish caught.

The hake is not a permanent resident in the Firth and for eight months of the year the catches of this species by Danish seine net were negligible. During the five years this method of fishing has been prosecuted in the Firth, hake have appeared in the steamer catches in appreciable numbers only during the four months June to September. The best month for hake in the steamer catches was July when the quantity landed realised almost half of the total value of all the fish caught that month.

Cod did not play an important rôle in the catches but its relative value was greatest during the first three months of the year and in the month of March it provided a mean contribution of nine per cent. to the value of the total catch.

The sequence of events each year with regard to the composition of the steamer catches was such as has been described above. There were differences in the seasonal composition of the catches from year to year but these did not materially change the character of the fishing. During the five months November to March, plaice was the dominant species in the steamer catches but lemon soles caught on the plaice grounds also added substantially to the value of the landings. Cod were caught in greatest numbers during the months of January, February and March and added to the value of the catches at this season. The best season was that of 1924 when it provided as high as 13 per cent. of the value of the catch for these months. The relatively small proportion of cod caught by the steamers during the first quarter of the year when they are working on the cod spawning grounds is probably due to the fact that the plaice seine net is the one most extensively used. A number of the steamers ceased fishing in the Firth after the month of March but those that remained gradually extended their operations to the deeper

water and witches became of greater relative value in the catches. As a rule it was during the months of April and May that witches were most in evidence but in the year 1922 this species contributed substantially to the catches during the four months May to August.

The fishing was carried on until the end of May mainly for the three species of flatfish — plaice, lemon sole and witch — but with the advent of June the haddock seine net was more extensively used in the expectation of striking the small shoals of hake entering the Firth at that time of the year. While the times of arrival and departure of the hake from the Firth vary only slightly from year to year, there are very considerable fluctuations in the numbers which enter its waters in the various years. In the summer of 1922 few entered the Firth and consequently the species did not appear in any appreciable numbers in the steamer catches. Small shoals of hake were located by the steamers in the other four years and contributed substantially to the catches mainly during the four months June to September. The best month was July and in 1924 and 1925 the species contributed 55 and 61 per cent. respectively of the value of all fish caught during that month. The hake appears to have prolonged its stay in the area in seasons 1923 and 1924, for in these years the quantities caught in September realised 20 and 28 per cent. respectively of the value of the total catches of fish.

With the departure of the hake from the Firth the haddock took a more prominent part in the composition of the catches but the share which it contributed to the value of the landings varied greatly. The best season was that of 1924, while the contribution in 1926 was also a good one. It is of interest to note that the share contributed by the haddock fell away in the month of November and as a rule remained comparatively small until the following July. The decline in the relative importance of the haddock thus early in the season was not due to the departure of the species from the Firth but to the fact that the steamers again reverted to the use of the plaice seine in the late months of the year.

Motor Boats.

In view of the fact that the changes in the composition of the steamer catches throughout the year have been treated at some length, there is no necessity to describe the catches of the motor boats in the same detail. The six species on which the steamers relied contributed over 90 per cent. of the value of the motor boat catches. It is to be noted, however, that the most intensive fishing was carried on by the motor boats of the Banff district and that as these vessels confined their operations mainly within a somewhat restricted area off the Banffshire coast, especially in the early months of the year, the combined data of the motor boat catches are largely influenced by the Banff landings.

The lemon sole took first place in the motor boat catches. The fishing for this species usually started in December and was carried on continuously until the end

of April. As can be seen from the table on page 192 the value of the lemon soles landed during these five months was far greater than the combined value of all the other species caught. The selection of the fishing grounds at this season of the year was determined by the abundance of lemon soles. While the plaice was the species next in importance to the lemon sole, its value in the motor boat catches during the period December to April depended on its frequency of occurrence on the lemon sole grounds. The share which these two species contributed to the value of the catches during this period of the year was over 85 per cent.

Lemon Sole and Plaice.

Mean Monthly Percentage Contributions. Motor Boats.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
92.8	89.4	87.1	67.4	37.9	11.8	24.4	42.9	31.3	25.5	32.7	84.9

After March, however, the relative importance of these two species rapidly fell away and in the month of June the quantity landed was so small that it did not fetch 12 per cent. of the value of the fish caught. The witch, which contributed an extremely small share to the value of the catches in the first three months of the year gradually increased in relative importance as the catches of the more valuable flatfish declined. The fact that the witch is so poorly represented in the catches of the first three months shows that they are not abundant on the lemon sole grounds and that their increasing importance in the following months was due to the motor boats changing their fishing grounds.

Plaice, Lemon Sole, Witch.

Mean Monthly Percentage Contributions. Motor Boats.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
94.6	92.0	94.1	83.8	68.8	37.8	37.4	64.5	57.4	40.7	52.3	89.5

Only during the months of June, July and October did the combined values of the lemon soles, plaice and witches fall below 50 per cent. of the gross total. Thus the operations of the motor boats were carried on mainly for the capture of flatfish. If the relative proportions of these three species of flatfish in the catches of the steamers and motor boats are compared throughout the year it is observed that with the exception of the first quarter of the year the witch always contributed a much larger share to the motor boat catches than it did to the steamer catches. This is probably due to the fact that after the month of March the motor boats fished more regularly than the steamers in the deep southern valley of the Firth where witches are most numerous.

With the appearance of the hake in the Firth the motor boats also changed over to the more regular use of the haddock seine net. The occurrence of this species in the motor boat catches was very similar to that in the steamer catches. In 1922

no hake were caught, while in 1923 and 1924 they were present in the catches much later in the season than in the remaining years of the period. As far as this species is concerned the motor boats were most successful in June and July of 1925, the contributions to the values of the total catches in these months being 71 and 58 per cent. respectively. So too, just as in the case of the steamer catches, the haddock began to improve in relative importance in the motor boat catches before the departure of the hake, and after the latter had left the weight of haddock was sufficiently large to represent half of the total value of the fish caught in October. After this month, however, haddock contributed a much smaller share and as the vessels reverted to the plaice seine the percentage values became very small. Cod never entered very largely into the composition of the motor boat catches and even during the spawning period its relative value was extremely small.

District Landings.

Steamers.

Aberdeen. As already stated the steamer landings at Aberdeen of fish caught in the Moray Firth present some features of special interest. The total value of all fish caught by steamers in the area during the period 1922—1926 amounted to £294,276 and of the gross total £60,402 — or approximately 20.5 per cent. — was realised from the landings made at that port. As may be seen from the following calculated values, the proportion of the total fish caught in the Firth which was landed at Aberdeen varied greatly at different seasons of the year.

Percentage Values of the Steamer Catches landed at Aberdeen.

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
9.2	18.5	52.5	10.7

Steamers exhibited a distinct preference for Aberdeen as the port of landing during the third quarter of the year when hake was an important constituent of the catches. There were, however, significant differences between the composition of the catches landed at Aberdeen and at the Moray Firth ports at all seasons of the year and this suggests that Aberdeen was used as a port of landing by steamers mainly on special occasions.

It has already been shown that plaice was the dominant species in the steamer catches during the first quarter of the year and that after the plaice-spawning season the lemon sole gained in relative importance in the second quarter of the year. During the three months July, August and September, however, the hake became a substantial contributor to the catches and as the numbers of this species in the Firth dwindled the haddock began to play a more important rôle in the later months of the year. Now if a comparison is made between the percentage compo-

Steamer Landings (1922—1926).
Mean Quarterly Percentage Contributions in Value.

Species	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Total Value in £s landed at Aberdeen 1922-1926
	Aberdeen	Moray Firth Ports	Aberdeen	Moray Firth Ports	Aberdeen	Moray Firth Ports	Aberdeen	Moray Firth Ports	
Plaice	*61.6*	51.4	26.9	31.6	16.7	24.5	28.2	48.3	17,546
Lemon Sole	28.1	28.5	*35.5*	27.8	18.2	11.1	25.6	16.9	14,194
Witch	0.5	4.4	1.8	15.1	—	8.1	—	3.6	1,392
Haddock	2.4	4.5	16.5	10.6	24.2	31.4	*34.5*	23.5	11,290
Hake	—	—	6.5	3.4	*33.6*	19.9	1.9	0.4	12,127
Cod	2.8	8.0	3.6	4.6	2.3	2.2	2.5	2.7	1,607

sition of the catches landed at Aberdeen and at the Moray Firth ports, it will be noted that although the sequence of changes in the composition of the catches landed at Aberdeen was similar to that for all steamer catches, the relative values of each of the four species mentioned above are in turn much greater in the Aberdeen landings than in the landings at Moray Firth ports. In other words, there was a tendency for the steamers to land their best catches at Aberdeen at all seasons of the year, such catches consisting mainly of the species dominant at the time. Cod and witches were very poorly represented in the Aberdeen landings, there being apparently no special inducement to the steamers to land good catches of these species there.

Motor Boats.

Banff, Fraserburgh and Findhorn. As already stated, the motor boats of the Banff district carried on the fishing most intensively during the first quarter of the year while there was a tendency for the Fraserburgh motor boats to prolong their operations into the second quarter. On the other hand, the motor boats in the Findhorn district, although fewer in number, continued the fishing throughout the whole year.

Motor Boats.
Mean Quarterly Percentage Values of the Total Landings.

District	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Value of Total Landings 1922—1926
Banff	66.1	16.1	4.6	13.2	£ 35,261
Fraserburgh	39.6	34.4	11.2	14.8	40,286
Findhorn	23.9	23.7	32.3	20.1	11,894

The motor boats have a much more restricted range of operations than the steamers — as a rule they fish on the grounds nearest to the port of landing. The grounds fished by the motor boats of these different districts are therefore more or less distinct from each other and consequently there are very marked differences in the composition of the catches. These differences are shown in the following table of percentage values.

Motor Boats.
Mean Quarterly Percentage Contributions to the Value of the Catches.
(1922—1926).

Species	Banff				Fraserburgh				Findhorn			
	Quarter				Quarter				Quarter			
	1	2	3	4	1	2	3	4	1	2	3	4
Plaice	11.4	12.4	1.2	15.3	14.9	0.6	1.2	10.7	*68.1*	*36.5*	*44.5*	*48.7*
Lemon Sole	*86.9*	*76.4*	18.5	*57.0*	*67.6*	13.2	10.4	32.3	6.8	*21.5*	10.8	10.5
Witch	0.4	1.4	1.3	1.0	9.1	*36.9*	*37.8*	24.6	3.1	7.1	9.5	3.6
Haddock	1.0	7.0	*59.7*	20.6	3.6	6.8	15.4	24.5	12.7	13.6	16.8	*30.0*
Hake	—	—	—	—	0.2	*25.6*	*29.7*	1.1	—	12.4	15.3	—
Cod	—	0.5	2.8	1.1	1.0	3.0	2.3	1.2	*7.8*	5.5	1.8	2.6

The Banff motor boats restrict their operations to a very limited area in the neighbourhood of the ports of landing and their catches consist almost exclusively of flatfish. This small area yields an extraordinarily high percentage of lemon soles especially in the first and second quarters of the year. Catches are largest in the first and second quarters of the year although in some years the lemon soles may collect on the grounds in the last weeks of December. Plaice are also present in this area in smaller numbers and they help to augment the value of the landings. When the catches of lemon soles and plaice fall off the fishing is gradually suspended until the following season, but the few vessels which continue the fishing, although they capture a few lemon soles and plaice, rely mainly on the haddock species in the third quarter of the year. Witches occur very sparingly and therefore contribute little to the landings of the Banff motor boats. The hake shoals do not penetrate to these grounds and only occasional specimens are found in the catches in the Summer months.

The grounds fished by the Fraserburgh fleet, although overlapping those fished by the Banff vessels, are much more extensive. During the last weeks in December and the first three months of the year the Fraserburgh vessels confine their attention mainly to the coastal grounds lying off Aberdour and adjacent to the Banff grounds with the result that their catches consist largely of lemon soles. There is, however, a somewhat higher proportion of plaice on these easterly grounds.

As the catches of lemon sole and plaice fall off, the Fraserburgh vessels seek the offshore grounds and witches become the main object of capture in the second quarter of the year. The hake entering the Firth *via* the southern valley are caught in June and witches and hake contribute the greater part of the catches until the end of September. In the later months the haddock provides an important quota to the catches until the vessels once more desert the offshore grounds.

The motor boats from the Findhorn district fish the inner waters of the Firth extending their operations to Tarbet Ness and beyond. Part of their operations therefore is carried out on grounds also fished by the steamers and in consequence the composition of their catches is somewhat similar to that of the latter. The plaice is the dominant species in the first quarter of the year and the lemon sole gains in relative importance in the second quarter, while hake and haddock are best represented in the third and fourth quarters respectively. In view of the fact that the operations of the Findhorn motor boats are carried on mainly in the inner section of the Firth cod are comparatively well represented in the catches during the spawning period when they are present in the area in shoals, but plaice is the most important species in the catches at all seasons of the year.

The Effect of the Incidence of Fishing on the Fish Stock of the Moray Firth.

Although the method of fishing by means of the Danish seine net has been in operation in the Moray Firth for a very brief period it is desirable even thus early to attempt to estimate the probable effect any increase in the intensity of fishing or change in its incidence may have on the fish population within the area. Before discussing the data available for the consideration of this question a resumé of the genesis and growth of the fishery may serve as a brief introduction.

Danish seine net fishing is a recent innovation in Scottish waters which so far has been exploited mainly by herring fishermen belonging to Moray Firth ports. As has already been stated the method was introduced at a time of acute depression in the herring fishing industry and in view of the fact that the conditions in that industry are still unstable and that experience of the method is comparatively short, there is considerable uncertainty as to the place it may take in future in the annual routine of the Scottish fisheries. During this short period fishing was carried on at all times of the year in the Moray Firth area with varying degrees of intensity by both steamers and motor boats. The vessels engaged in this fishery were drawn from the drift net fishing fleet and many of them reverted to the herring fishing whenever prospects in that branch appeared favourable. The crews of all these vessels, however, remain essentially drift net fishermen and when prospects in the herring fishing become brighter the seasonal incidence of Danish seine net fishing may undergo still further changes. The vessels used in the drift net fishing

by Scottish fishermen can be readily adapted to Danish seine net operations and, in so far as the drift net fishermen are concerned, it is probable that when more stable conditions are restored this method of fishing will remain as one of the alternative methods adopted during the periods between herring fishing seasons.

Some of the factors having a bearing on the growth of Danish Seine net fishing at various centres have already been considered. With regard to the incidence of the fishing in the Moray Firth area, it was noted that the fishing was developed at each of the centres in characteristic fashion. Within this short period the motor boats steadily gained in relative importance suggesting that the remunerative results are more favourable to this type of vessel than to the steamer. In fact the indications are, that when more normal conditions in the herring fishing are restored Danish seine net fishing will be carried on mainly by medium-sized motor boats whose working expenses are light. There was also a tendency for both types of vessels to concentrate on the fishing mainly during the early months of the year, when the value of the catch is due largely to the capture of the valuable species of flatfish present in the Firth.

The plaice seine was the type of net most used during the early months of the year. As the season advanced and the catches of flatfish declined those vessels which continued the fishing resorted more and more to the use of the haddock seine, a type of net better adapted for the capture of such species as haddock, hake and cod, but less efficient for the capture of plaice, lemon soles and witches than the plaice seine. Changes in the relative abundance of the various species in the landings do not necessarily indicate similar changes in the relative abundance of the species on the fishing grounds. The proportion of the stock of any species taken from the area by the fishing operations at any particular moment depends not only on the degree of concentration of the species on the fishing grounds and on the intensity of fishing operations, but also on the type of net used.

No distinction is made in the statistics between the catches by plaice seine and haddock seine. It is shown, however, in the discussion on the changes in the composition of the catches throughout the year that the variations occurring in each year were more or less similar. This recurring sequence of changes in the composition of the catches suggests that the selection of the fishing grounds and the type of gear used are determined largely by the annually recurring cycle of biological events in the Moray Firth. Unless radical changes occur in the relative abundance of the more important species or in the conduct of the fishery — and the short experience of the operations does not suggest any immediate radical changes — the data provide a useful basis for an estimate of the effect of the fishing operations at different times of the year on the fish population of the Firth.

The data of the seven most important species for the five year period 1922 to 1926 have been combined and the monthly percentages of the total annual catch by weight for each species are given in the accompanying table and diagram.

Moray Firth. — Danish Seine Net.
Steamer and Motor Boat Landings 1922—1926 (incl.). Percentage of the Catch taken in each month.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total catch in cwts. 1922—1926 incl.
Plaice	16.7	*25.3*	22.0	8.7	3.9	1.4	2.0	3.2	5.3	4.5	3.5	3.5	35029
Lemon Sole	17.3	17.9	*25.0*	12.7	6.9	1.8	2.1	4.0	4.0	2.2	1.1	4.9	25330
Witch	4.5	6.1	14.6	*18.9*	16.6	10.6	5.0	9.0	6.4	4.0	2.9	1.5	12248
Haddock.....	5.8	5.6	4.9	4.3	6.4	6.8	7.4	16.9	*18.8*	14.0	6.4	2.7	41324
Hake	0.1	0.1	0.2	0.2	2.4	22.6	*33.9*	24.7	15.0	0.7	0.1	0.0	23117
Cod	7.9	22.1	*30.9*	10.6	6.0	4.0	3.5	5.1	3.6	2.8	2.0	1.5	17189
Skate.....	9.6	12.8	13.6	13.0	9.6	3.3	3.8	7.2	9.6	6.9	6.3	4.2	8331

These percentages represent the mean quotas of the annual stock of the important species which were taken each month from the area by the fishing operations under the conditions as to loci of fishing, incidence of fishing, type of gear used etc. obtaining in the period 1922 to 1926. There were variations in the different years but the same broad features are observable in the records for each year as is shown in the table and diagram. The heaviest landings of plaice, lemon sole and cod were made in the first three months of the year, while the greatest weight of witches landed did not occur until April. In the comparatively short season from June to September when hake appeared in the catches the greatest quantities were landed in the month of July. The relative quantities of haddock landed in each month were very variable in the different years but as a rule the heaviest landings were made in August, September or October. There was, however, a falling off in the total quantities of haddock landed in the last two months of each year although there was no decrease in the intensity of fishing at that period. As already stated this decrease in the quantity of haddock landed was not due to the departure of the species from the Firth but to the fact that the vessels again concentrated on the capture of the more valuable flatfish.

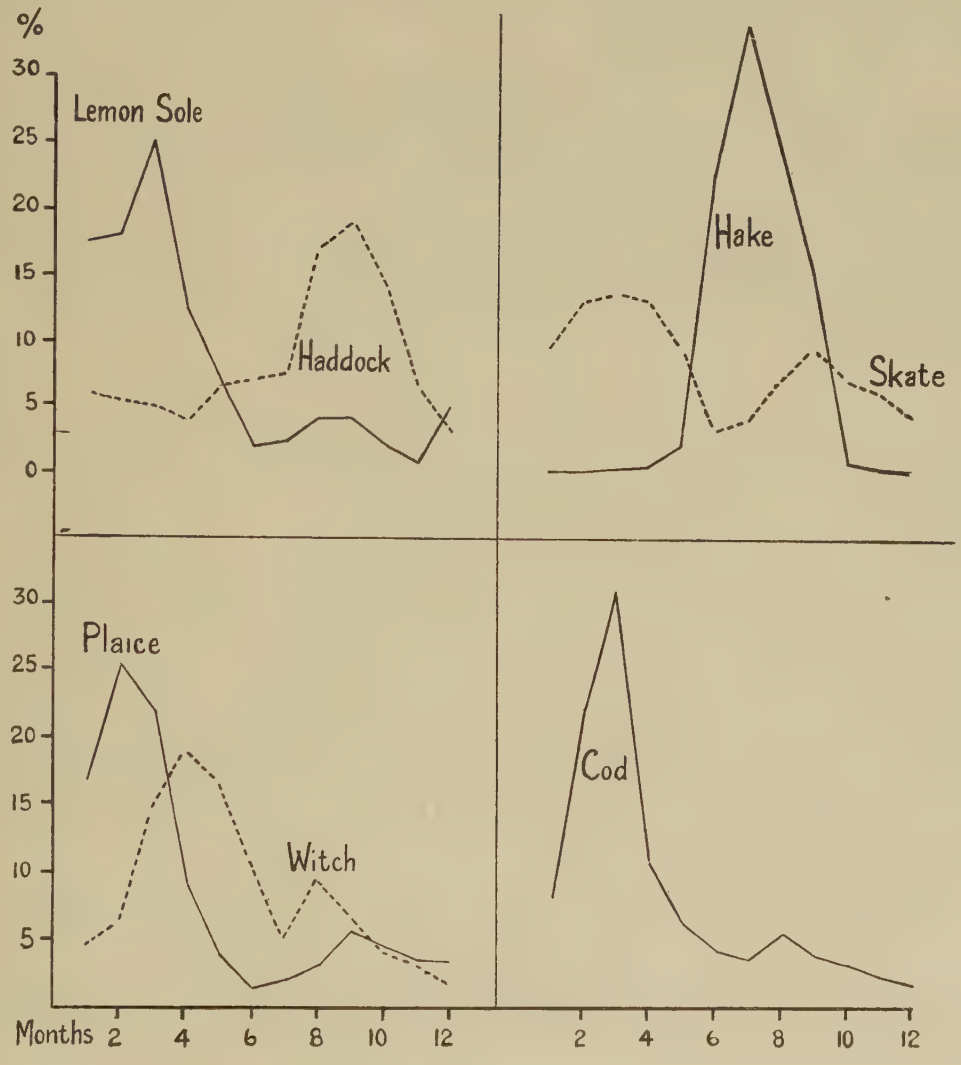
A more detailed examination of the percentage weights given in the above table shows that in the first three months of the year when plaice and lemon soles were the main object of the fishery 64 and 60 per cent. respectively of the total annual catch of these two valuable species were landed. Sixty-one per cent. of the gross annual weight of cod was taken in the same time. This latter species occurs only incidentally in the catches, and the high percentage weight taken in the first three months of the year was due to the presence of large spawning cod on the plaice grounds. The quota of the annual catch of haddock caught during the first quarter of the year was however very low and amounted to only 16.3 per cent. of the total catch. On the other hand, the greatest toll of the haddock stock was

MORAY FIRTH

DANISH SEINE NET (STEAM & MOTOR)

TOTAL CATCH 1922-26.

Monthly Percentages



taken in the autumn months when the number of landings was comparatively few; 50 per cent. of the year's catch was landed during the three months August, September and October. The proportions of the plaice and lemon sole catches taken during these same months were 13 and 10 per cent. respectively. Thus any increase in the intensity of fishing for plaice and lemon sole in the early months of the year would affect the haddock population to a very small extent, while increased attention to the haddock fishing in the autumn months would take only a relatively small additional toll of the stock of plaice and lemon sole. In view of the much greater value weight for weight of the lemon sole and plaice compared with the haddock it is unlikely that the spring fishery will develop into a haddock fishery unless the stocks of lemon sole and plaice in the Firth become so small that fishing for these species will be unremunerative.

During the few years the fishery has been in existence the motor boats have gained in relative importance. As the grounds fished by the motor boats were not co-extensive with those fished by the steamers there were differences in the composition of the catches made by these two types of vessels. The effect on the fish population of variations in the numbers of vessels employed and their incidence of fishing must therefore be considered for each type of vessel separately.

The mean quarterly percentage quotas of the annual catches taken by steamers and motor boats are given in the accompanying table.

Danish Seine Net 1922—1926.
Quarterly Percentages of the Total Weight Caught.

Species	Steamers				Motor Boats			
	Quarters				Quarters			
	1	2	3	4	1	2	3	4
Plaice	65.4	13.5	10.3	10.8	53.6	17.6	12.1	16.7
Lemon Sole	55.4	22.7	14.7	7.2	67.6	19.5	3.3	9.6
Witch	32.5	40.4	21.4	5.8	14.1	54.6	18.8	12.5
Haddock	16.9	14.9	48.4	19.9	14.4	26.0	25.8	33.8
Hake	0.4	11.2	87.7	0.8	0.4	66.6	32.2	0.7
Cod	64.6	17.8	11.8	5.8	29.6	44.0	15.0	11.4
Percentages of Landings	55.7	17.2	14.1	13.1	52.0	24.8	8.4	14.8

The lines on which the fishery has developed so far suggest that in future the motor boats will become of relatively greater importance. The incidence of fishing throughout the year was very similar for both steamers and motor boats. It is to be noted, however, that most of the steamers abandoned the spring fishery earlier than the motor boats and did not return to Danish seine net fishing in the Firth

until the following spring although a few were attracted to the area in the autumn months during the hake season, more especially in those years when that species was abundant. If the steamer landings of hake at Aberdeen in the third quarter of the year are omitted from the calculations the incidence of fishing by steamers and motor boats agrees very closely. In both cases the fishing was essentially a spring one and the close agreement between the quarterly percentages of landings of steamers and motor boats suggests that the seasonal incidence of the fishing will remain more or less constant even if there are variations in the number of boats employed.

Direct comparison is made in the following table between the absolute quantities of lemon sole and plaice taken from the area by steamers and motor boats in the different quarters of the year during the period under review.

Plaice and Lemon Soles.
Number of Landings and Total Catches in cwts. (1922—1926).

	Jan.—March		April—June		July—Sept.		Oct.—Dec.		Total 1922—1926	
	Steamers	Motor Boats	Steamers	Motor Boats	Steamers	Motor Boats	Steamers	Motor Boats	Steamers	Motor Boats
Number of Landings.....	5058	5608	1558	2669	1279	903	1186	1589	9081	10769
Plaice	20077	2318	4122	762	3172	526	3328	724	30699	4430
Lemon Sole	8525	6714	3501	1936	2259	327	1121	947	15406	9924

Under the conditions prevailing in the years 1922 to 1926 the steamers caught almost 7 times the weight of plaice caught by the motor boats, but during the first three months of the year only, they caught a relatively much higher proportion, the weight being almost 8.7 times that caught by the motor boats. On the other hand the steamers caught only 1.6 times the weight of lemon soles taken by the motor boats, while for the first three months the ratio was approximately 1.3. In other words, even if there should be no radical change in the incidence of fishing and in the conduct of the fishery, an increase in the relative numbers of steamers would tend to take a much greater toll of the plaice than an equivalent increase in the number of motor boats, while an increase in the relative number of motor boats would tend to affect the stock of lemon soles more than an equivalent increase in the number of steamers. An increase in the relative proportions of motor boats in the Findhorn district would, however, have an adverse effect on the plaice stock as these vessels fish mainly on the plaice grounds throughout the whole year.

Annual Fluctiations in the Catches.

In the detailed statistics the catches taken by steamers and motor boats from the Moray Firth and landed within each district have been separately distin-

guished and the monthly data as to the number of landings and weights of the species of fish caught are available for each of the complete years. Although the fishing grounds most frequented by the vessels fishing from the various ports have been described the exact locus of fishing for the various landings is not known. The different species of fish are not uniformly distributed throughout the area at any season of the year and hence variations in the catches may be due to the selection of different fishing grounds and not to variations in the abundance of the fish.

The number of hours spent by each vessel in actual fishing operations — the best measure of the intensity of fishing — is not known. The number of day's absence of the vessel from port is a less satisfactory measure of the intensity of fishing as it includes the time taken on the voyage to and from the fishing grounds. Even if there are no interruptions to the fishing operations by adverse weather conditions etc., the number of hours' fishing per day depends on the number of daylight hours available. A day's absence from port in summer represents a greater number of hours' fishing than a day's absence in winter. During the year 1926, however, the number of days' absence of each vessel from port was included in the data and from the records it is observed that while there are variations in the number of days spent on a voyage the average number of days' absence differs in the different districts. In other words, the average catches at the different ports are not strictly comparable even if the vessels have been fishing on the same grounds.

While the number of landings is not a good index of the intensity of fishing, it is the best one available for the five years under consideration. The fishing grounds within the Firth are within easy range of the ports and, as has already been seen, the fishing is carried on in a more or less regular manner from each district. For any particular district therefore the intensity of fishing is approximately proportional to the number of landings and the monthly data for the different years for each district provided the best means available for ascertaining the fluctuations in the abundance of fish on the different fishing grounds from year to year.

It has already been shown that there is another difficulty. Two types of net which differ from each other with respect to their efficiencies of capture of the different species are used in the fishing operations. The seasonal variations in the average landings of the different species therefore do not necessarily correspond to the seasonal fluctuations of the species on the fishing grounds. During the first four months of the year, however, when the plaice and lemon sole are the most important species for the fishing, the plaice seine is the net almost invariably used, but after April an increasing proportion of the catches is made with the haddock seine. It is therefore only for the first four months of the year that comparisons of the average catches of flatfish within the different districts can be made with any degree of confidence.

The mean catches in cwts. per hundred landings for the four quarters of the year have been calculated for the important species for both steamers and motor boats and are given in the following table:—

Steam and Motor Danish Seine. 1922—1926.
Mean Catches (in cwts.) per 100 Landings.

Species	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Whole Year	
	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor	Steam	Motor
Plaice	397	41	265	29	248	58	280	46	338	40
Lemon Sole	169	120	225	73	177	36	95	60	170	92
Witch	47	12	192	99	124	100	36	38	81	45
Haddock	106	25	305	93	1200	272	533	203	350	89
Hake	1	—	124	146	1184	208	12	3	190	54
Cod	196	10	175	30	142	31	71	13	169	17

These calculations emphasise some of the characteristic differences between the catches of steamers and motor boats which have already been demonstrated. The average weight per landing for motor boats was almost invariably very much less for all species than that for the steamers. The comparatively low average weight of fish landed by motor boats was due mainly to the fact that most of their landings were the results of fishing operations for only one day's absence from port. The difference between the average weights per landing for the different species for the two types of vessels are however significant. In the case of cod and plaice the average weights of a steamer's landings are 10 and 8.5 times respectively those of a motor boat's landings. In the first three months of the year, however, the average weight of cod in each shot landed by steamers was 20 times that landed by motor boats, while the average weights of plaice caught per trip by steamers in the first and second quarters of the year were 9.7 and 9.1 times those of the motor boats. The average duration of a motor boat trip is much less than that for a steamer and in a season a motor boat may make from two to three times as many trips as a steamer. If the conduct of the fishing were to remain unchanged and there were no changes in the fishing grounds frequented by steamers and motor boats, the addition of one steamer to the fleet would be equivalent to the addition of three or four motor boats with regard to its effect on the plaice stock, while in the case of the cod the effect would be similar to the addition of from 3 to 5 motor boats. On the other hand, the average weight per landing of the lemon soles in the steamer catches was only 1.8 times that for motor boats. Hence in a given time a motor boat, making short trips but operating regularly on the grounds now fished, would capture as many lemon soles as a steamer making longer trips and operating on more distant grounds where the species is relatively less numerous. Again, as may be seen from the table, four motor boats took approximately the same quota of the haddock and hake stock from the Firth as three steamers.

For each of the years of the period under review the average monthly catches

per 100 landings of the more important species have been calculated for each district. There are considerable variations in each of the years in the monthly average catches per 100 landings for all species and in order to eliminate as far as possible these irregularities in the data the mean catches per 100 landings have been summed for each species for the months in which it was dominant in the catches and the figures obtained have been used as approximate measures of the relative abundance of each species from year to year.

Plaice.

During the early months of the year the plaice seine net was used almost exclusively, the plaice and lemon sole contributing together by far the greater share of the catches of both steamers and motor boats during these months. After the month of March, however, the catches of plaice decreased and lemon sole gained in relative importance, more particularly in the steamer catches. For the plaice species therefore the comparison of its relative abundance in the various years has been restricted to the first quarter of the year.

Plaice.

Steam Danish Seine.

Summation of Mean Monthly Catches (Jan.—March) in cwts. per 100 Landings.

	1922	1923	1924	1925	1926
Findhorn	1372	1163	1438	1430	758
Buckie	2254	2277	2779	3214	1668
Banff	592	336	110	223	187
Aberdeen	4600	—	—	4782	2590
All Steamers	1658	1000	1274	1216	657

There are considerable differences in the index figures for the various districts due mainly to the differences in the number of days' absence from port. The Buckie steamers, proceeding longer distances from port, usually made two trips per week and fished off the north-west coast, while the Findhorn steamers usually made three trips a week to the nearer grounds. The index figures for Aberdeen in the three years for which data are available for all three months are very high. Vessels with exceptionally good catches of plaice, landed these at Aberdeen. In all districts, however, 1926 was an extremely poor year for the capture of plaice by steamers. It is obvious that the data are quite inadequate for detailed analysis of the conditions but in the first four years of the period they afford no apparent evidence of any serious decline in the weight of plaice in the Firth.

Plaice.

Motor Danish Seine.

Summation of Mean Monthly Catches (Jan.—March) in cwts. per 100 Landings.

	1922	1923	1924	1925	1926
Findhorn	464	—	1041	630	271
Buckie	380	361	325	789	241
Banff	—	238	76	85	40
Fraserburgh	47	17	53	57	25
All Motor Boats	149	39	45	57	22

The motor boats, except those which operate from the Findhorn district, do not specialise in the plaice fishing in the first three months of the year. The Buckie calculations are based on a very small number of landings. On the other hand, the Fraserburgh boats during the first two years carried on the fishing in the deeper water where witches are more frequent and therefore caught few plaice. The statistics of the different districts are therefore not comparable but they agree with the results for the steamers in the fact that in every district the year 1926 was a very unsuccessful one for the plaice fishing in the first quarter of the year.

Lemon Sole.

Steam Danish Seine.

Summation of Mean Monthly Catches (Jan.—April) in cwts. per 100 Landings.

	1922	1923	1924	1925	1926
Findhorn	49	74	67	69	91
Buckie	896	895	1018	1036	1116
Banff	1122	1520	1472	978	918
Aberdeen	648	—	—	600	772
All Steamers	161	173	195	173	177

In view of the fact that the intensive fishing for lemon sole was carried on somewhat later than that for the plaice the index figures for this species have been obtained by the summation of the average catches per 100 landings for each district for the first four months of the year. As in the case of the plaice the calculations for the Buckie district are based on a relatively small number of landings. It is evident from the table that the Banff steamers fished on grounds where lemon soles were much more abundant than on the grounds fished by the Findhorn steamers. As a matter of fact the Banff steamers fished the same grounds in the neighbourhood of the port of landing, as the motor boats from the same district fished intensively, grounds where the plaice species does not occur in abundance. This fact and the fact that the trips were of short duration explain why the index figures for plaice in the Banff steamer catches are so low. With regard to the lemon soles in the

Banff steamer catches it will be noted that there was a distinct falling off in the abundance of fish on these grounds during the first four months of the years 1925 and 1926.

Lemon Soles.

Motor Danish Seine.

Summation of Mean Monthly Catches (Jan.—March) in cwts. per 100 Landings.

	1922	1923	1924	1925	1926
Findhorn	90	—	78	25	165
Banff	692	1190	503	317	317
Fraserburgh	81	6	153	159	145
Buckie	167	144	283	228	252
All Ports	171	107	132	100	100

Lemon Soles are poorly represented in the catches of the motor boats fishing from Lossiemouth. Only in the Banff district are the data for each year sufficiently comprehensive to provide reliable averages. It will be noted that just as in the case of the steamer catches in the same district there was a falling off in the abundance of lemon soles on these grounds in the early months of the years 1925 and 1926.

Witch.

When the numbers of plaice and lemon soles diminish a number of the vessels proceed to fish the deeper water where witches are found in greater abundance than on the shallower grounds. The mean monthly catches of witches per 100 landings have therefore been summed for the four months March, April, May and June without reference to districts.

Witch.

Summation of Mean Monthly Catches (March—June) in cwts. per 100 Landings.

	1922	1923	1924	1925	1926
Steamers	1710	490	418	476	246
Motor Boats	319	977	448	200	373

There are considerable variations from year to year in the index figures for both types of vessels, owing to the fact no doubt that the witch fishing is not a special one at this time of the year in the same sense as the lemon sole and plaice fishings are in the earlier months. The number of visits which these vessels make to the witch grounds depends in great measure on the prospects of the fishing for plaice and lemon sole and also later for hake.

Haddock.

Danish Seine Net.

Summation of Mean Monthly Catches in cwts. (Aug.—Oct.) per 100 Landings.

	1922	1923	1924	1925	1926
Steamers	1489	3287	5441	2176	6280
Motor Boats	1420	1541	898	749	678

These index figures can only be taken as representing the relative abundance of the species on the grounds fished. During at least two of the months, August and September, the boats which have remained at the fishing prefer to frequent those areas where hake are likely to be found.

Hake.

The following are the comparable data for the hake, the index figures being obtained from the summation of the mean monthly landings for the four months June to September.

Danish Seine Net.

Summation of Mean Monthly Catches in cwts. (June—Sept.) per 100 Landings.

	1922	1923	1924	1925	1926
Steamers	387	3341	7378	4321	3129
Motor Boats	25	197	1431	1654	1683

It is evident from the table that season 1922 was a poor one for hake both for steamers and motor boats. The best year for the steamers was 1924, while 1925, 1923 and 1926 were also favourable years in the above order of importance. The best year for hake for the motor boats was however 1926 but 1925 was almost equally good. In the year 1924 the motor boats did not strike the hake in as dense shoals as the steamers and in 1923 they were comparatively unsuccessful. It is of interest to note that the largest catches of hake generally occur earlier in the season in the motor boat catches than in the steamer catches. In season 1926 the bulk of the catch was obtained by motor boats in June.

Cod.

Danish Seine Net.

Summation of Mean Monthly Catches in cwts. (Jan.—April) per 100 Landings.

	1922	1923	1924	1925	1926
Steamers	508	471	1245	552	1024
Motor Boats	222	75	31	40	49

It has already been shown that the motor boats do not catch the large spawning cod in the spring months in the same proportion as the steamers and this fact is well illustrated in the above table. In view of the fact that no distinction

has been made in the statistics between the mature cod and codling it is not possible to compare the steamer and motor boat catches with reference to the relative abundance of these two categories on the grounds fished during the early spring months.

Steam

Total

Months	January		February		March		April		May	
Arrivals	*260*		*457*		*445*		*266*		*128*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	216	*386*	688	*725*	614	*375*	363	*269*	155	*90*
Haddock	652	*1195*	550	*832*	283	*309*	259	*285*	293	*296*
Hake	—	—	2	*2*	6	*5*	2	*3*	15	*7*
Lemon Sole	269	*1523*	644	*2665*	832	*2895*	554	*2180*	226	*858*
Plaice	1480	*7238*	2978	*8292*	1947	*5283*	1083	*3447*	249	*842*
Witch	276	*760*	345	*938*	858	*1703*	660	*1371*	472	*1012*
Skate	164	*147*	189	*104*	302	*126*	210	*105*	137	*32*
Unclassified	131	*264*	246	*355*	304	*243*	356	*318*	206	*203*
Total...	3188	*11513*	5642	*13913*	5146	*10939*	3487	*7978*	1753	*3340*

Months	January		February		March		April		May	
Arrivals	*132*		*232*		*359*		*134*		*48*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	152	*236*	159	*290*	560	*417*	176	*234*	128	*124*
Haddock	105	*177*	83	*140*	169	*211*	110	*215*	98	*146*
Hake	—	—	—	—	2	*3*	—	—	8	*19*
Lemon Sole	153	*856*	288	*1554*	794	*3497*	247	*1447*	201	*1031*
Plaice	594	*2975*	501	*2373*	1865	*6393*	272	*1386*	217	*959*
Witch	25	*76*	43	*145*	132	*359*	114	*403*	58	*146*
Skate	61	*55*	62	*48*	134	*70*	84	*66*	53	*27*
Unclassified	26	*49*	56	*59*	233	*225*	176	*187*	166	*134*
Total...	1116	*4424*	1192	*4609*	3889	*11175*	1179	*3938*	929	*2586*

The lack of sufficiently detailed data and the short period during which the fishing has been in operation precludes any definite conclusions being drawn as to changes in the fish stock in the Firth as far as the Danish seine net fishery is concerned.

1922

August *54*		September *121*		October *181*		November *105*		December *54*		Total *2143*	
Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
106	*65*	70	*54*	70	*54*	118	*124*	48	*50*	2601	*2280*
184	*186*	692	*865*	1042	*1151*	356	*414*	47	*66*	4594	*5856*
52	*32*	74	*115*	19	*26*	3	*5*	—	—	235	*254*
88	*299*	186	*871*	144	*666*	43	*218*	29	*129*	3082	*12509*
106	*293*	675	*2727*	759	*2883*	451	*2096*	249	*1128*	10123	*34608*
564	*785*	111	*275*	103	*214*	27	*84*	39	*108*	4054	*8230*
120	*15*	180	*54*	143	*41*	131	*94*	70	*46*	1727	*778*
58	*113*	75	*111*	137	*116*	26	*54*	11	*13*	1646	*1931*
1278	*1788*	2063	*5072*	2417	*5151*	1155	*3089*	493	*1540*	28062	*66446*

1923

August *122*		September *288*		October *228*		November *132*		December *75*		Total *1780*	
Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
92	*85*	123	*128*	130	*120*	87	*87*	50	*49*	1742	*1827*
1623	*1805*	3561	*3480*	1644	*1851*	714	*1125*	87	*132*	8291	*9394*
1274	*1380*	1764	*2278*	81	*101*	7	*8*	3	*3*	3337	*4038*
329	*1662*	357	*1618*	201	*946*	85	*417*	43	*219*	2807	*13646*
448	*1951*	681	*2899*	382	*1707*	364	*1515*	187	*818*	5628	*23413*
238	*638*	222	*613*	126	*362*	46	*135*	6	*17*	1111	*3168*
255	*111*	391	*189*	248	*126*	144	*81*	56	*28*	1551	*818*
86	*130*	165	*182*	186	*161*	167	*151*	40	*37*	1356	*1358*
4345	*7762*	7264	*11387*	2998	*5374*	1614	*3519*	472	*1303*	25823	*57662*

Months	January		February		March		April		May	
Arrivals	*164*		*270*		*355*		*156*		*155*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codlings	210	*306*	1118	*1341*	1784	*1904*	312	*322*	252	*216*
Haddock	152	*310*	127	*244*	343	*593*	382	*661*	1023	*1559*
Hake	3	*6*	—	—	2	*2*	9	*16*	16	*24*
Lemon Sole	407	*2173*	622	*3037*	569	*2851*	249	*1280*	425	*1764*
Plaice	537	*2493*	1690	*6352*	1139	*4491*	417	*1777*	494	*1707*
Witch	43	*158*	55	*175*	151	*412*	312	*839*	182	*393*
Skate	56	*45*	139	*54*	199	*85*	124	*58*	195	*85*
Unclassified	64	*81*	169	*254*	278	*258*	397	*357*	465	*332*
Total...	1472	*5572*	3920	*11457*	4465	*10596*	2202	*5310*	3052	*6080*

Months	January		February		March		April		May	
Arrivals	*311*		*439*		*359*		*195*		*76*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	207	*306*	749	*1329*	570	*607*	303	*309*	140	*115*
Haddock	351	*350*	329	*396*	246	*245*	288	*234*	336	*290*
Hake	5	*5*	5	*7*	7	*9*	15	*16*	114	*152*
Lemon Sole	407	*2161*	835	*4841*	782	*3249*	232	*1198*	222	*692*
Plaice	1076	*4739*	1991	*8253*	1496	*5590*	311	*1445*	88	*260*
Witch	49	*151*	84	*249*	97	*252*	312	*818*	159	*237*
Skate	219	*107*	354	*215*	139	*85*	150	*102*	130	*68*
Unclassified	138	*152*	301	*348*	233	*231*	315	*399*	174	*131*
Total...	2452	*7971*	4648	*15638*	3570	*10268*	1926	*4521*	1363	*1945*

Months	January		February		March		April		May	
Arrivals	*538*		*368*		*369*		*143*		*34*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	453	*579*	853	*833*	1583	*1414*	399	*224*	89	*53*
Haddock	729	*461*	756	*493*	485	*394*	114	*57*	58	*33*
Hake	5	*5*	10	*10*	9	*10*	2	*3*	—	—
Lemon Sole	1027	*5950*	407	*2206*	489	*2570*	591	*2326*	208	*609*
Plaice	1160	*5870*	1005	*4079*	618	*2777*	515	*1912*	80	*263*
Witch	55	*197*	101	*291*	83	*241*	136	*266*	24	*48*
Skate	198	*115*	201	*111*	192	*105*	204	*124*	57	*28*
Unclassified	246	*185*	235	*176*	249	*194*	345	*269*	84	*46*
Total...	3873	*13362*	3568	*8199*	3708	*7705*	2306	*5181*	600	*1080*

1924

August *192*		September *87*		October *41*		November *24*		December *3*		Total *1695*	
Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	Cwts.	Cwts.	£	Cwts.	£
426	*327*	176	*148*	91	*81*	51	*46*	1	*1*	4840	*5003*
3888	*5261*	1589	*2707*	652	*1002*	135	*200*	12	*11*	10985	*15715*
3748	*4514*	1425	*1614*	15	*13*	3	*3*	—	—	11193	*12925*
298	*1123*	119	*541*	54	*238*	31	*136*	9	*50*	3274	*14986*
220	*916*	116	*534*	75	*360*	46	*186*	15	*77*	5262	*21157*
36	*87*	17	*49*	9	*20*	27	*72*	1	*2*	972	*2504*
98	*49*	73	*47*	41	*18*	40	*18*	6	*3*	1227	*585*
231	*162*	133	*93*	64	*60*	30	*29*	1	*1*	2203	*1897*
8945	*12439*	3648	*5733*	1001	*1792*	363	*690*	45	*145*	39956	*74772*

1925

August *43*		September *45*		October *8*		November *7*		December *109*		Total *1677*	
Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
116	*97*	105	*99*	27	*24*	10	*10*	50	*60*	2388	*3032*
235	*235*	323	*383*	73	*83*	10	*13*	118	*121*	2621	*2623*
370	*467*	—	—	7	*8*	1	*1*	1	*1*	1942	*2060*
170	*701*	121	*589*	27	*122*	18	*91*	247	*1345*	3112	*15195*
120	*575*	103	*472*	40	*175*	52	*254*	157	*749*	5469	*22669*
16	*43*	13	*33*	7	*22*	4	*10*	13	*43*	809	*1969*
45	*33*	18	*9*	28	*15*	8	*4*	81	*43*	1204	*694*
19	*32*	15	*23*	5	*6*	3	*5*	56	*43*	1299	*1417*
1091	*2183*	698	*1608*	214	*455*	106	*388*	723	*2405*	18844	*49659*

1926

August *12*		September *60*		October *51*		November *49*		December *119*		Total *1786*	
Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
63	*60*	60	*56*	47	*47*	36	*36*	68	*67*	3774	*3475*
488	*352*	564	*419*	649	*715*	379	*498*	404	*453*	5295	*4422*
125	*176*	47	*56*	—	—	3	*3*	1	*1*	573	*551*
40	*162*	108	*472*	26	*141*	37	*207*	127	*753*	3131	*15665*
44	*193*	136	*576*	147	*661*	144	*760*	260	*1301*	4217	*18735*
1	*2*	11	*32*	2	*7*	12	*34*	5	*20*	447	*1190*
28	*16*	72	*35*	28	*15*	76	*39*	89	*50*	1184	*656*
7	*8*	24	*24*	21	*17*	39	*30*	82	*66*	1368	*1043*
796	*969*	1022	*1670*	920	*1603*	726	*1607*	1036	*2711*	19989	*45737*

Steam Danish Seine Net Vessels.

Aberdeen.

Catches from Outside Moray Firth Area.

Year	1922		1923		1924		1925		1926	
Arrivals	*343*		*562*		*453*		*172*		*46*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	1406	*958*	1337	*1061*	1016	*823*	656	*490*	123	*84*
Haddock	3022	*3978*	7263	*8916*	1778	*2672*	1683	*1782*	117	*118*
Hake	3	*3*	20	*24*	415	*478*	362	*357*	117	*79*
Lemon Sole	1745	*6898*	3687	*16880*	3973	*16425*	745	*3078*	479	*2265*
Plaice	7446	*22836*	7851	*31365*	6308	*26536*	2273	*8395*	624	*2734*
Witch	605	*1070*	1036	*2626*	790	*1838*	157	*351*	70	*137*
Skate	1033	*275*	2189	*989*	2499	*1103*	506	*217*	122	*75*
Unclassified	884	*1012*	2147	*2405*	2897	*2404*	899	*719*	108	*106*
Total	16144	*37030*	25530	*64266*	19676	*52279*	7281	*15389*	1760	*5598*

Moray Firth.

Motor Danish Seine.

Total Landings for all Ports. **1922.**

Month	January		February		March		April		May		June		July		August		Septbr.		Octbr.		Novbr.		Decbr.		Total	
Arrivals	29		63		121		143		41		2		5		4		9		15		16		18		466	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	6	*11*	78	*83*	64	*33*	35	*29*	39	*20*	2	*1*	7	*5*	7	*5*	6	*4*	13	*9*	4	*4*	3	*4*	264	*208*
Haddock	25	*39*	60	*90*	46	*50*	57	*65*	57	*51*	11	*7*	20	*21*	17	*18*	20	*28*	116	*94*	68	*80*	56	*81*	553	*624*
Hake	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	*2*	..	..	..	..	1	*1*	2	*3*
Lemon Sole	32	*225*	81	*478*	293	*986*	201	*704*	72	*275*	2	*4*	..	..	7	*33*	32	*124*	4	*21*	3	*15*	6	*34*	733	*2899*
Plaice	29	*131*	166	*473*	124	*328*	106	*346*	69	*237*	8	*19*	47	*167*	10	*37*	20	*89*	33	*132*	37	*157*	17	*76*	666	*2192*
Witch	10	*25*	18	*41*	65	*129*	74	*151*	26	*48*	3	*4*	51	*122*	..	..	6	*9*	1	*3*	..	..	20	*50*	274	*582*
Skate	5	*4*	22	*12*	34	*16*	38	*18*	26	*9*	..	..	..	..	..	..	7	*2*	19	*6*	14	*10*	5	*4*	170	*81*
Unclassified	..	..	31	*38*	31	*28*	41	*32*	30	*33*	2	*4*	4	*4*	1	*2*	6	*9*	8	*7*	7	*7*	2	*2*	163	*166*
Total	107	*435*	456	*1215*	657	*1570*	552	*1345*	319	*673*	28	*39*	129	*319*	42	*95*	98	*267*	194	*272*	133	*273*	110	*252*	2825	*6755*

Moray Firth.

Motor Boats.

Total Landings for all Ports. **1923.**

Month	January		February		March		April		May		June		July		August		Septbr.		Octbr.		Novbr.		Decbr.		Total	
Arrivals	24		73		361		269		93		61		20		43		116		125		134		63		1382	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	11	*21*	2	*2*	43	*33*	38	*57*	48	*55*	50	*38*	7	*4*	18	*15*	18	*19*	20	*30*	28	*48*	19	*32*	302	*354*
Haddock	24	*39*	3	*6*	24	*34*	39	*71*	70	*88*	102	*89*	39	*46*	135	*151*	575	*511*	914	*955*	555	*734*	119	*187*	2599	*2911*
Hake	..	..	..	..	1	*2*	2	*3*	13	*23*	17	*20*	1	*1*	27	*31*	118	*185*	26	*47*	6	*14*	1	*1*	212	*327*
Lemon Sole	33	*174*	116	*593*	469	*1928*	162	*816*	50	*249*	46	*166*	8	*26*	14	*73*	17	*75*	35	*150*	25	*135*	11	*62*	986	*4447*
Plaice	31	*148*	17	*85*	132	*419*	37	*167*	39	*177*	47	*218*	43	*158*	70	*310*	55	*250*	51	*210*	38	*185*	34	*161*	594	*2488*
Witch	29	*90*	31	*107*	253	*618*	224	*669*	332	*870*	285	*628*	3	*6*	128	*366*	315	*747*	147	*394*	191	*495*	84	*201*	2022	*5191*
Skate	10	*9*	7	*6*	35	*25*	28	*24*	47	*39*	40	*13*	22	*6*	33	*17*	49	*38*	35	*28*	40	*43*	15	*12*	361	*260*
Unclassified	16	*94*	12	*13*	119	*70*	131	*103*	219	*158*	57	*42*	3	*9*	8	*8*	54	*44*	147	*90*	137	*79*	43	*33*	946	*743*
Total	154	*575*	188	*812*	1076	*3129*	661	*1910*	818	*1659*	644	*1214*	126	*256*	433	*971*	1201	*1869*	1375	*1904*	1020	*1733*	326	*689*	8022	*16721*

Moray Firth.

Motor Danish Seine.

Total Landings for all Ports. **1924.**

Month	January		Febr.		March		April		May		June		July		August		Septbr.		Octbr.		Novbr.		Decbr.		Total	
Arrivals	*376*		*348*		*534*		*397*		*185*		*123*		*226*		*80*		*111*		*188*		*80*		*176*		*2824*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	16	*31*	26	*39*	33	*35*	51	*50*	38	*39*	44	*42*	54	*53*	30	*31*	40	*34*	70	*55*	5	*5*	9	*10*	416	*424*
Haddock	41	*85*	28	*54*	33	*49*	137	*154*	254	*248*	362	*430*	558	*684*	281	*386*	305	*558*	513	*837*	192	*238*	158	*182*	2862	*3905*
Hake	..	..	..	..	..	..	5	*9*	34	*46*	1075	*1242*	864	*1053*	119	*178*	29	*35*	8	*13*	..	..	..	..	2134	*2576*
Lemon Sole	617	*3067*	515	*2317*	669	*3156*	384	*1975*	132	*565*	19	*73*	23	*95*	15	*60*	17	*69*	28	*106*	6	*30*	73	*423*	2498	*11936*
Plaice	228	*979*	164	*616*	177	*639*	179	*714*	52	*182*	14	*55*	37	*134*	58	*234*	20	*72*	34	*134*	41	*153*	117	*517*	1121	*4429*
Witch	43	*119*	30	*79*	87	*269*	213	*514*	364	*627*	223	*421*	111	*257*	113	*259*	76	*209*	77	*196*	21	*62*	22	*66*	1380	*3078*
Skate	37	*34*	26	*19*	48	*34*	109	*97*	54	*50*	13	*7*	7	*5*	6	*4*	7	*5*	12	*11*	15	*16*	12	*14*	346	*296*
Unclassified	37	*24*	25	*18*	101	*85*	251	*294*	350	*276*	110	*58*	158	*83*	55	*30*	38	*23*	118	*139*	39	*51*	27	*25*	1309	*1106*
Total	1019	*4339*	814	*3142*	1148	*4267*	1329	*3807*	1278	*2033*	1860	*2328*	1812	*2364*	677	*1182*	532	*1005*	860	*1491*	319	*555*	418	*1237*	12066	*27750*

Moray Firth.

Motor Danish Seine.

Total Landings for all Ports. **1925.**

Month	January		February		March		April		May		June		July		August		Septbr.		Octbr.		Novbr.		Decbr.		Total	
Arrivals	*455*		*347*		*503*		*511*		*221*		*140*		*89*		*40*		*29*		*19*		*22*		*286*		*2662*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	39	*65*	52	*95*	23	*27*	61	*56*	82	*65*	98	*83*	34	*27*	18	*16*	9	*5*	3	*3*	2	*2*	9	*7*	430	*451*
Haddock	152	*198*	139	*166*	182	*195*	222	*177*	199	*145*	235	*160*	177	*133*	105	*106*	48	*54*	61	*54*	71	*54*	73	*77*	1664	*1519*
Hake	..	..	17	*26*	1	*2*	3	*4*	298	*304*	1395	*1443*	575	*477*	5	*7*	..	..	..	..	..	..	..	..	2294	*2263*
Lemon Sole	419	*2459*	324	*1748*	660	*2563*	406	*1807*	121	*407*	25	*95*	19	*87*	31	*128*	29	*113*	14	*51*	3	*11*	512	*2632*	2563	*12101*
Plaice	439	*1935*	185	*717*	116	*384*	73	*265*	26	*63*	21	*72*	12	*52*	15	*68*	12	*47*	21	*80*	13	*55*	45	*192*	978	*3930*
Witch	16	*58*	20	*54*	27	*66*	126	*268*	272	*369*	68	*124*	88	*198*	2	*5*	1	*2*	3	*8*	1	*3*	..	..	624	*1155*
Skate	50	*39*	26	*21*	21	*13*	69	*61*	65	*50*	6	*4*	7	*5*	1	*1*	3	*1*	11	*5*	2	*1*	3	*3*	264	*204*
Unclassified	27	*29*	24	*21*	47	*31*	155	*164*	229	*163*	58	*41*	21	*14*	3	*2*	1	*1*	..	..	..	..	2	*5*	567	*471*
Total	1142	*4783*	787	*2848*	1077	*3281*	1115	*2802*	1292	*1566*	1906	*2022*	933	*993*	180	*333*	103	*223*	113	*201*	92	*126*	644	*2916*	9384	*22094*

Moray Firth.

Motor Danish Seine.

Total Landings for all Ports. **1926.**

Month	January		February		March		April		May		June		July		August		Septbr.		Octbr.		Novbr.		Decbr.		Total	
Arrivals	*882*		*819*		*673*		*299*		*115*		*69*		*57*		*37*		*37*		*37*		*50*		*360*		*3435*	
	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£	Cwts.	£
Cod and Codling	44	*35*	72	*74*	36	*30*	84	*72*	53	*32*	88	*68*	14	*10*	4	*3*	10	*10*	9	*8*	11	*12*	7	*8*	432	*362*
Haddock	171	*147*	250	*172*	199	*128*	175	*92*	250	*119*	308	*131*	65	*51*	30	*29*	80	*64*	141	*125*	156	*174*	35	*39*	1860	*1271*
Hake	2	*3*	..	..	6	*4*	6	*8*	48	*50*	992	*914*	136	*139*	1	*1*	1	*1*	2	*2*	1	*1*	..	..	1195	*1123*
Lemon Sole	1015	*5270*	700	*3591*	771	*3798*	179	*730*	102	*341*	35	*127*	50	*202*	27	*116*	38	*179*	13	*72*	19	*93*	195	*1217*	3144	*15736*
Plaice	263	*1067*	152	*555*	95	*330*	37	*119*	46	*159*	8	*32*	41	*183*	44	*200*	42	*181*	27	*130*	57	*271*	159	*669*	971	*3896*
Witch	1	*3*	21	*44*	34	*80*	140	*254*	144	*247*	157	*352*	4	*7*	2	*4*	13	*36*	15	*45*	23	*83*	1	*4*	555	*1159*
Skate	4	*4*	37	*25*	28	*19*	68	*48*	37	*29*	18	*12*	8	*4*	10	*4*	3	*2*	12	*6*	58	*35*	14	*11*	297	*199*
Unclassified	9	*6*	33	*24*	49	*51*	201	*147*	123	*93*	64	*55*	6	*2*	3	*1*	..	..	2	*5*	28	*19*	9	*8*	527	*411*
Total	1509	*6535*	1265	*4485*	1218	*4440*	890	*1470*	803	*1070*	1670	*1691*	324	*598*	121	*358*	187	*473*	221	*393*	353	*688*	420	*1956*	8981	*24157*

Occurrences of Non-British Trawlers in The Moray Firth

by

A. Bowman, D. Sc.

The first authentic instance of a non-British trawler observed fishing in the Moray Firth was reported on 12th February 1895. During the year 1897 eight vessels of non-British nationality were noted at work within the Firth. In the following year the number had increased to 28, which were observed on 60 occasions engaged in fishing operations. From the year 1899 detailed records have been kept of the trawlers observed each year and the locus of fishing has been noted on each separate occasion. The observations have been made by British fishery cruisers systematically employed in the Firth on fishery protection duties.

The following data give the details for each year:—

	1899	1900	1901	1902	1903
a) Number of non-British Vessels observed	49	40	27	20	23
b) Number of Occasions on which observed	154	210	136	205	189

	1904	1905	1906	1907	1908
do. (a)	32	30	33	25	39
do. (b)	279	279	149	201	219

	1909	1910	1911	1912	1913
do. (a)	42	38	50	64	42
do. (b)	213	234	207	226	234

	1914	1915	1916	1917	1918
do. (a)	59	—	—	—	—
do. (b)	243	—	—	—	—

	1919	1920	1921	1922	1923
do. (a)	1	17	33	11	14
do. (b)	1	39	81	22	24

	1924	1925	1926
do. (a)	13	15	22
do. (b)	18	51	53

Naturally there were no visits during the war years (1914—1918) and the first recorded appearance of a trawler within the area thereafter occurred in September 1919. The fleet of trawlers frequenting the Firth has not regained pre-war strength and has consisted of a comparatively small number of Belgian and Dutch vessels with an occasional German vessel, these fishing mainly in the winter and spring months. The winter and spring was also the period of greatest activity in the pre-war years but then a number of vessels continued to trawl within the area during the summer and autumn months.

In view of the fact that the patrol of the Firth by the fishery cruisers is carried out systematically, the records of occurrences give some approximation to the relative intensity of trawling during the various months, and as the locus of trawling has been determined on each occasion, the fishing grounds most favoured by the non-British vessels at different seasons of the year may also be defined with some precision.

Moray Firth — Non-British Trawlers. 1898—1925.
Monthly Percentages of Occurrences.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1898—1914 ..	396	447	599	440	238	163	146	153	190	194	223	266	3455
% ..	11.4	12.9	17.3	12.7	6.9	4.7	4.2	4.4	5.5	5.6	6.5	7.7	
1919—1925 ..	21	74	24	20	18	5	3	1	5	3	15	46	235
% ..	9.0	31.5	10.2	8.5	7.7	2.1	1.3	0.4	2.1	1.3	6.4	19.6	
1898—1925 ..	417	521	623	460	256	168	149	154	195	197	238	312	3690
% ..	11.3	14.1	16.9	12.5	6.9	4.5	4.0	4.2	5.3	5.3	6.4	8.4	

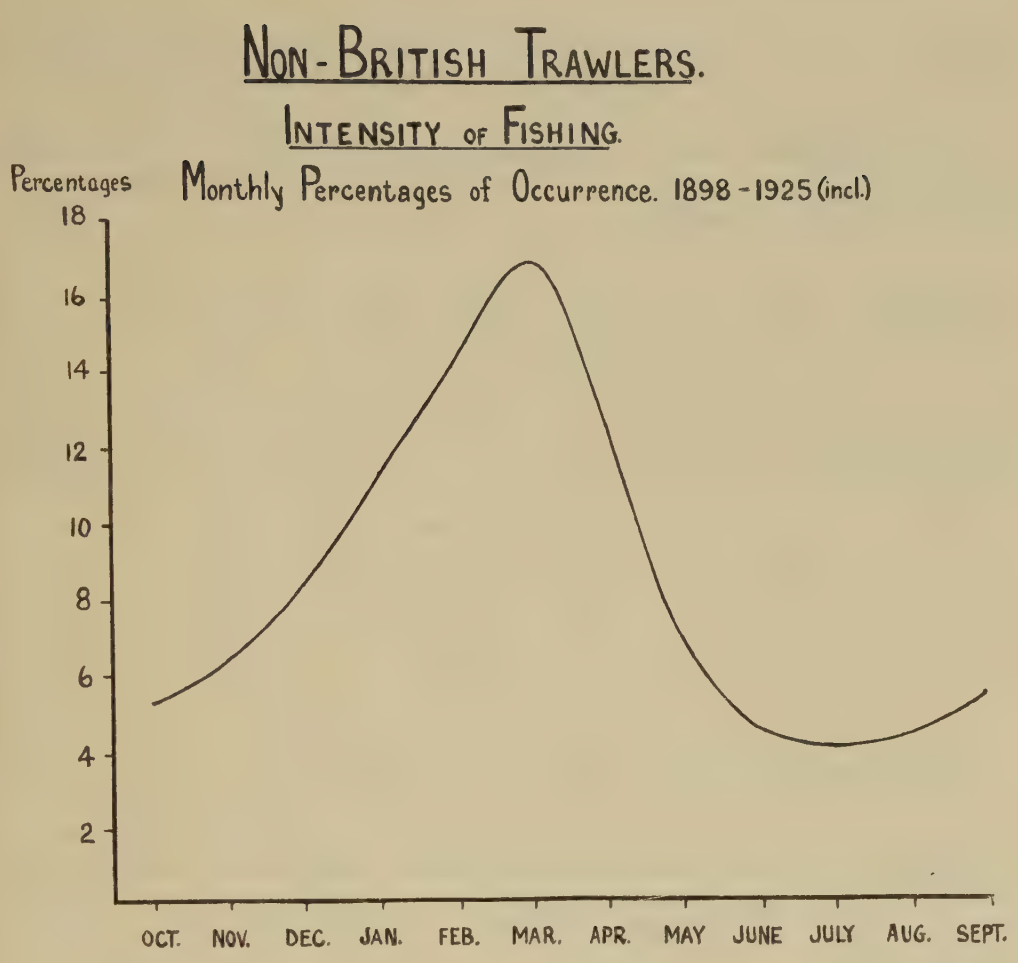
There are slight differences in the monthly incidence of the fishing in each of the pre-war years, but the general trend of the fishing is the same for all years and therefore a combination of the data for all years presents a fair average picture of the conditions. The months most favoured were the first four months of the year, the fishing reaching its greatest intensity in the month of March. The accompanying graph shows the general trend of the fishing throughout the year.

There is least activity in the months of June, July and August, but the visits become more frequent in September to culminate in March after which month there is a marked falling off.

During the post-war years the number of visits of non-British trawlers has been relatively few, but, as will be seen from the figures, these visits have been mainly in the months December to March (inclusive), the most favoured month being February.

The percentage of occurrences for the different quarters of the year is as follows: —

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
42.3	23.9	13.5	20.1



For the six months November to April (inclusive) there are 69.6 per cent. of the occurrences for the whole period under consideration, but for the post-war years over 85 per cent. of the fishing took place during these months. The months most favoured for trawling in the Moray Firth are those just prior to and covering the spawning periods of the plaice, cod and haddock.

The Loci of Fishing.

For purposes of tabulation the Moray Firth has been divided into small areas by lines at each 5′ Latitude and 10′ Longitude, each area or small square being numbered according to plan and the number of occasions on which non-British trawlers have been reported fishing being entered in the appropriate square (see Chart p. 225). It will be noted from the results that the part of the Firth most frequented by the trawlers lies to the west of the line 2°50′ W. Longitude. Less

than $6^1/_2$ per cent. of the occurrences were reported to the east of this line (231 occasions out of a total of 3,690). On 89 occasions the exact locations of fishing were not specified.

Even within the region of the Firth to the west of the line 2°50′ W. Longitude certain localities are more favoured than others. There are three major areas in which the vessels concentrate:—

A. Between Noss Head and Berriedale (58°10′ N.);
B. Within a radius of not more than fifteen miles from Tarbet Ness;
C. Off Spey Bay between Lossiemouth and Portsoy.

The relative frequencies of occurrences on these concentration areas may be compared from the following approximate figures. The occurrences have been found by combining the figures in adjacent squares at each centre of concentration.

Area	Occurrences	Percentage of Total
Northern	833	21.5
Tarbet Ness	1,444	37.3
Spey Bay	740	19.1
	3,017	*77.9*

Thus the most important area is the Tarbet Ness area. In the three areas combined almost 78 per cent. of the trawling is carried on.

Even within these three major areas there are specially favoured grounds. For example, in the northern area there are three concentration points, namely, between Noss Head and Sarclet Head, south-east of Clyth Ness and on Smith Bank.

Off Tarbet Ness most of the trawling is carried on within a ten mile radius and in the third area the trawling is mainly concentrated on the grounds off Spey Bay.

With regard to these most favoured localities, however, there are distinct differences in the incidence of the trawling throughout the year. These differences may be demonstrated by an analysis of the seasonal occurrences.

	Season. Percentages of Occurrences.			
Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Northern	32.2	*40.4*	16.9	10.4
Tarbet Ness	*55.1*	16.6	7.2	21.2
Spey Bay	*39.0*	14.0	18.5	28.5

Thus over half of the trawling in the inner part of the Firth in the Tarbet Ness area occurs in the first quarter of the year. It is evident, however, that the vessels have begun to concentrate there during the last months of the year and

that after the spring spawning season the fishing rapidly takes off and becomes comparatively unimportant in the third quarter.

The area to the east of Spey Bay is also most intensively trawled in the first quarter of the year, but while the vessels appear to pay least attention to this locality in the second quarter they begin to be attracted there as early as the third quarter. The area is thus more uniformly fished throughout the year than the inner area off Tarbet Ness.

In the northerly parts of the Firth trawling is not pursued intensively in the last quarter of the year and although operations are carried on with considerable vigour in the first quarter, it is the second quarter of the year which appears to be the most favoured period for the locality.

More detailed analysis might be made with regard to the incidence of the trawling, but it is sufficient to point out that at different loci within these major areas there are differences in the incidence throughout the year. While the second quarter of the year is the most important one in the northern area the grounds off Noss Head receive relatively more attention in the first quarter than the other localities, while on Smith Bank the third and also the fourth quarters of the year gain in relative importance. It is in the area immediately adjacent to Clyth Ness where trawling is carried out with the greatest intensity in the second quarter of the year.

In the Spey Bay area trawling is relatively most important in the eastern section in the third and fourth quarters, while in the westerly section the fourth and first quarters are most favoured.

In the Tarbet Ness area the grounds off Brora are the most intensively trawled of any in the Firth and these receive most attention in the first quarter of the year.

No doubt the shelter afforded in the inner parts of the Firth permits of trawling being carried on there with greater regularity from October to March than in the outer parts of the Firth. The great attraction, however, is the appearance there of the spawning shoals. In all probability the fishing vessels seek the inner areas in the last quarter of the year mainly for haddock and plaice, but with the advent of the new year the shoals of spawning cod are the chief attraction. As the season advances, the larger haddock leave the inner area for the offshore spawning grounds, the plaice scatter after spawning, and the cod become spent. After March the fishing becomes more general and there is a tendency for the vessels to seek those grounds where a mixed catch may be obtained. This is particularly evident from the increased attention given to the more northerly grounds where lemon soles at this period of the year serve as an additional attraction.

It is to be remarked that during the months January to April the most favoured fishing grounds of the non-British trawlers coincide to a great extent with the grounds frequented by local vessels engaged in fishing for cod by means of anchored cod-nets.

The Intensity of Trawling in the Inner and Outer Portions of the Firth.

Most of the trawling is carried on in the inner parts of the Firth within the area bounded by the 30-fathom contour line of depth or, if in greater depth, in its near vicinity. Beyond a range of 13 miles from the coast the number of times non-British trawlers have been observed at work is less than 5 per cent. of the total records and beyond 10 miles of the coast the number of occurrences does not exceed 16 per cent. of the total.

It is convenient however to divide the Firth into inner and outer sections by imaginary lines drawn between two headlands on opposite sides of the Firth (see Chart), and the following table gives the relative intensity of trawling in the inner part of the Firth within the lines indicated.

Relative Intensities of Fishing by non-British Trawlers within the specified lines. Expressed as Percentages of Total Trawling in Moray Firth.

	Lossiemouth	Buckie	Troup Head
Ord of Caithness (Berriedale)	36.7	52.2	65.8
Clyth Ness.....	50.0	66.6	78.2
Sarclet Head	52.0	72.3	85.1
Noss Head.....	—	76.5	91.2

Thus throughout the year approximately 78 per cent. of the trawling by non-British trawlers is carried out within the line Clyth Ness—Troup Head and closure of the Firth to their operations within this line would reduce their activities by four-fifths.

The following table gives the relative amount of trawling carried on in the inner sections of the Firth from October to March (inclusive) expressed as percentages of the total amount of trawling carried on throughout the Firth for the whole year.

Intensity of Fishing by non-British Trawlers in Six Months October—March (inclusive). Expressed as Percentages of Total Trawling for the year within the Whole Firth.

	Lossiemouth	Buckie	Troup Head
Ord of Caithness (Berriedale)	28.0	38.9	47.8
Clyth Ness.....	35.8	46.7	53.5
Sarclet Head	36.3	49.3	56.1
Noss Head.....	—	57.3	59.0

For the six months January to June (inclusive) the following are the comparable figures:—

	Lossiemouth	Buckie	Troup Head
Ord of Caithness (Berriedale)	25.7	34.3	42.3
Clyth Ness.....	34.5	44.9	51.3
Sarclet Head.....	36.7	47.8	55.5
Noss Head.....	—	50.7	59.8

It is interesting, however, to compare the similar table for the first three months of the year January to March, i. e. during the height of the spawning season for cod, haddock and plaice.

First Quarter January—March (inclusive).

	Lossiemouth	Buckie	Troup Head
Ord of Caithness (Berriedale)	19.9	26.5	32.1
Clyth Ness.....	25.2	32.3	35.9
Sarclet Head.....	26.1	33.5	37.8
Noss Head.....	—	35.1	39.9

Thus closure of the Firth within the line Sarclet Head to Troup Head to non-British trawlers for the first three months of the year would be as effective as closure of the Firth within the line Ord of Caithness—Lossiemouth for the whole year. Closure of the Firth within the line Noss Head—Troup Head for either of the six-monthly periods would be more effective than closure of the Firth within the line Ord of Caithness—Buckie and would restrict the operations of non-British trawlers by more than one half.

A statement showing the number and nationalities of the non-British trawlers observed trawling in the Moray Firth during the period 1896—1925 is attached. Since 1909 it has been contrary to British law to land the catches made by the trawlers at ports in the United Kingdom and no statistics of the catches are available. Efforts have recently been made to obtain statistics of the catches made by Belgian trawlers which worked in the Moray Firth in the spring of 1926 but the data furnished are incomplete. It would appear to be desirable that a complete and detailed record of the operations of trawlers in the Firth and of the results should be established.

The following extract from "Der Fischerbote" (December 1910, No. 12, p. 329) of a statement attributed to an old German trawl skipper is of interest:— "That large plaice have no need for space or depth is proved also by the large catches of plaice which were made 12 years ago off the Scottish coast in the Moray Firth. In this bay according to Scottish law Scottish trawlers may not fish. A Danish trawler first discovered in the bay large fishing grounds. This was soon known to Germany and Geestemünde, Hamburg and Altona steamers steamed there to fish. I was also present amongst the first of those with my steamer. Large and medium

cod and large plaice were caught in such quantities that after we had fished a few days the fish-hold was filled to overflowing. The catches were brought to Grimsby and Hull because these towns were significantly nearer than Hamburg and Altona. The Moray Firth hauls consisted, as has already been said, in large proportion of large cod as well as large and medium plaice, the latter from 150—300 cwts. per voyage. After about 5—6 months the area was completely fished by trawlers, so fishing was stopped as it no longer paid. Next year various trawlers sought this fishing ground but the plaice had for ever disappeared from the Moray Firth."

Numbers and Nationalities of non-British Trawlers observed at work in the Moray Firth from 1896 to 1926.

Year	Norwegian		Swedish		German		French		Belgian		Dutch		Danish		Total	
	Number of trawlers observed	Number of occasions on which observed	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions	Number of trawlers	Number of occasions
*1896	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..
*1897	..	..	..	..	4	..	..	..	2	..	..	..	2	..	8	..
*1898	..	..	..	..	9	17	4	9	9	15	1	1	5	18	28	60
1899	3	21	..	..	23	41	5	15	10	26	2	8	6	43	49	154
1900	7	34	..	..	4	14	..	..	6	11	10	27	13	124	40	210
1901	14	97	..	..	2	5	..	..	3	5	2	3	6	26	27	136
1902	14	182	1	7	..	..	..	..	2	8	2	3	1	5	20	205
1903	13	156	1	8	..	..	..	..	8	23	1	2	..	..	23	189
1904	25	259	1	9	..	..	..	..	4	8	2	3	..	..	32	279
1905	28	277	..	..	..	..	..	..	1	1	..	..	1	1	30	279
1906	32	148	..	..	..	..	..	..	1	1	..	..	..	..	33	149
1907	17	178	1	3	1	2	..	..	6	18	..	..	..	..	25	201
1908	15	140	3	10	..	..	..	..	10	27	2	4	9	38	39	219
1909	10	74	3	10	1	1	..	..	7	16	5	6	16	106	42	213
1910	8	144	..	..	5	12	..	..	9	26	7	15	9	37	38	234
1911	8	115	2	13	22	44	..	..	6	9	11	15	1	11	50	207
1912	7	87	7	26	32	53	..	..	6	18	10	24	2	18	64	226
1913	6	115	1	4	11	18	..	..	7	21	13	30	4	46	42	234
1914	6	68	..	..	11	22	..	..	13	51	22	60	7	42	59	243
1915	Nil.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1916																
1917																
1918																
1919	..	..	..	..	..	..	..	..	1	1	..	..	..	..	1	1
1920	..	..	..	..	1	1	..	..	11	31	5	7	..	..	17	39
1921	..	..	..	..	4	10	..	..	14	35	15	36	..	..	33	81
1922	..	..	..	..	4	6	..	..	6	14	1	2	..	..	11	22
1923	..	..	..	..	6	6	..	..	8	18	..	..	..	..	14	24
1924	..	..	..	..	4	5	..	..	9	13	..	..	..	..	13	18
1925	..	..	..	..	..	..	..	..	15	51	..	..	..	..	15	51
1926	..	..	..	..	2	3	..	..	13	34	7	16	..	..	22	55

* The figures given for these years are only approximate.

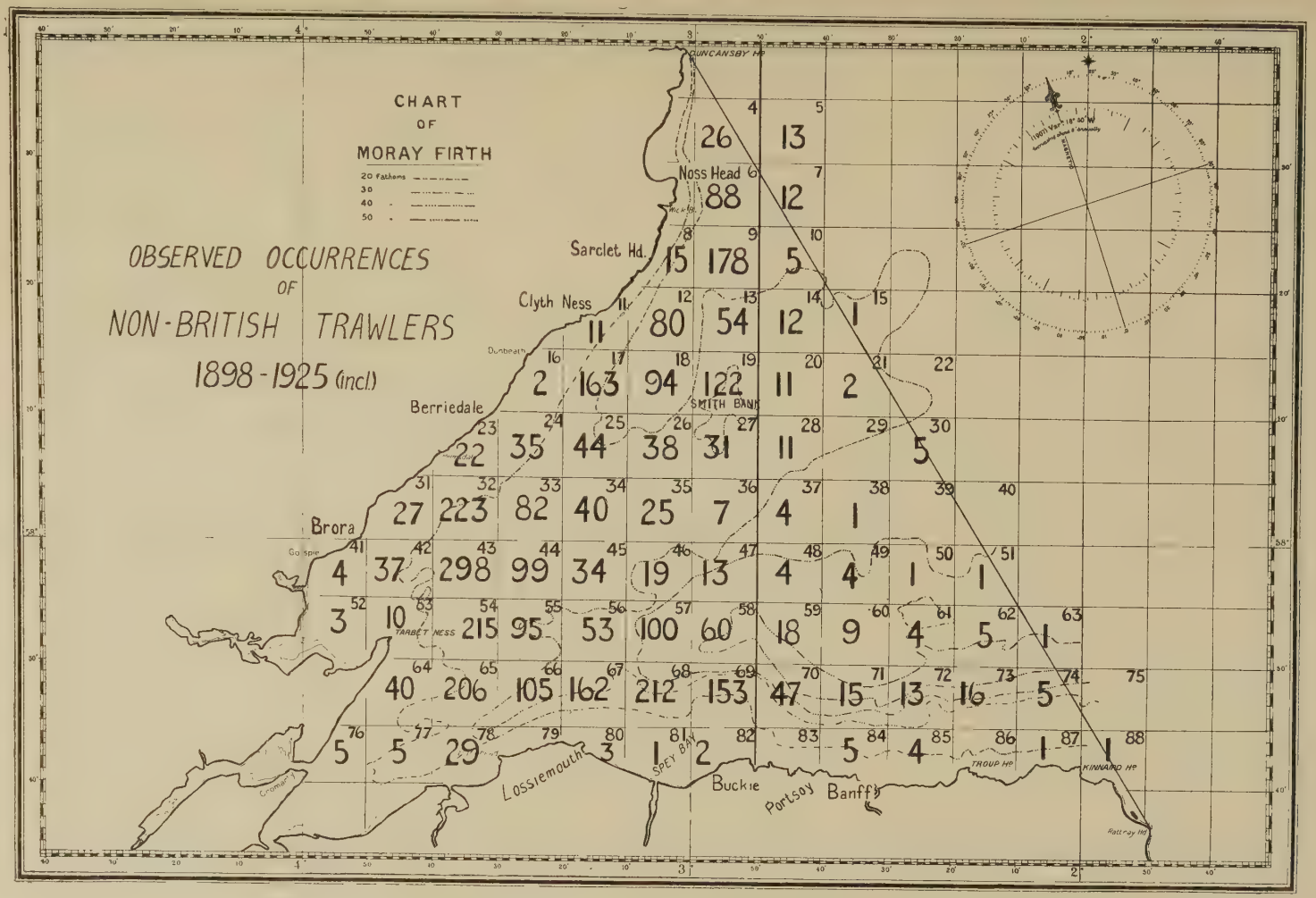


CHART
OF
MORAY FIRTH
20 Fathoms
30
40
50
OBSERVED OCCURRENCES
OF
NON-BRITISH TRAWLERS
1898-1925 (incl.)
DUNCANSBY HD
Noss Head
Sarclet Hd.
Clyth Ness
Dunbeath
Berriedale
SMITH BANK
Brora
Golspie
TARBET NESS
Cromarty
Lossiemouth
SPEY BAY
Buckie
Portsoy
Banff
TROUP HD
KINNAIRD HD
Rattray Hd
26 13
88 12
15 178 5
11 80 54 12 1
2 163 94 122 11 2
22 35 44 38 31 11 5
27 223 82 40 25 7 4 1
4 37 298 99 34 19 13 4 4 1 1
3 10 215 95 53 100 60 18 9 4 5 1
40 206 105 162 212 153 47 15 13 16 5
5 5 29 3 1 2 5 4 1 1

Paper No. 11.

General Considerations.

The Qualitative Effect of Different Fishing Gears on the Stock of the Marketable Species

by

A. Bowman, D. Sc.

The haddock, cod, plaice and lemon sole, the four species of greatest economic importance in the Moray Firth, are typical demersal fish from a very early period in their life, and from a consideration of their life histories it is obvious that the question of the qualitative effect of the action of the different types of commercial fishing apparatus on the stock must be treated separately for each species. In dealing with this question, however, attention need not be restricted to the conditions in the Moray Firth area. Experimental evidence from other fishing grounds as to the qualitative effect of gear may, as a rule, be applied generally.

It is hardly necessary to consider in detail the qualitative effect of line fishing on the stocks of those four species. The lemon sole is practically immune from capture by hook and plaice are taken by this method in appreciable numbers only at certain seasons of the year on inshore areas very restricted in extent.

The small line fishing carried on from Scottish ports is essentially a fishery for haddock. The method used has undergone no change for generations, and the gear is well adapted by size of hook and strength of snood for the capture of all the marketable sizes of haddock which frequent the small line grounds. Haddock below marketable size are less readily taken by hook, although in good years for capture of "smalls" they may sometimes be numerous in the catches. These unmarketable sizes, however, are normally inhabitants of the deeper offshore grounds and since small line fishing is carried on usually in proximity to the coast within 30 fathoms depth, few haddock of less than one and a half years old are caught. The fishing is carried on merely on the fringe of the area of distribution of the unmarketable sizes and the most intensive period of fishing is when the adult feeding migrants have invaded the shallower grounds. Codling of sizes similar to those of the haddock but in smaller numbers are also captured by small lines. The upper limit of size captured is determined by the strength of the snoods and the size of the hooks.

Hand line fishing and particularly the branch of it known as "ripper" fishing carried on in the near neighbourhood of the coast is largely dependent for its success on the abundance of immature cod of two years and upwards. It is prosecuted with vigour only on certain coastal grounds of limited extent and the quantities of codlings caught are relatively small. Both small and hand line fishing are practically negligible with respect to their qualitative effect on the stock.

Cod-net fishing is designed principally for the capture of mature cod although a few of the smaller boats set nets in the inshore waters for the capture of codlings. In the Moray Firth cod-net fishing is carried on only during the first three or four months of the year and owing to the size of the mesh used the majority of the fish caught are large mature forms. The toll taken of the spawning stock depends on the intensity of fishing and the degree of concentration of the shoals within the area. The spawning fish in the Moray Firth form only a very small proportion of the total spawning stock of the North Sea, but this proportion varies from year to year according to the routes taken by the spawning shoals.

The methods of fishing which demand attention are those known as otter trawling and seine net fishing.

In Scottish waters the plaice, an inhabitant of the shallow coastal zone in the early years of its life, remains immune from capture by trawl until with increasing age and size it seeks the offshore grounds beyond the territorial limit. Within the three-mile limit it may be captured by seine net on the Scottish east coast where this method of fishing is permitted, but the minimum size limit for plaice so caught is 8 inches (20.3 cm.).

The period of immunity from capture by trawl for the plaice depends largely on the rate of growth of the individual and the rapidity with which the depth of water increases offshore. If the 20-fathom contour line of depth be traced round the Scottish coast it will be found to conform more or less closely to the contour of the coast line and to run at a distance of approximately three miles from it. From the records of plaice caught in Scottish waters by research vessels over a number of years from depths of more than 20 fathoms, it is noted that much less than 10 per cent. by numbers are under 25 cms. (10 inches) in length. This statement is confirmed by the records of plaice from Scottish waters landed on the markets by commercial trawlers. "Undersized" plaice do not play the same rôle in the Scottish fisheries as they do in those of the southern North Sea. While the conditions of the shallow sandy bays of the Scottish coast are, on a small scale, not unlike the conditions of the small fish grounds in the south-east of the North Sea, the rapidly shelving coast permits the growing plaice of less than 25 cm. to secure suitable depth within the territorial zone. The three-mile limit in Scottish waters is therefore a protection against the capture by trawl of the greater proportion of such fish. Soon after reaching 25 cm. in length the plaice seek depths of more than 20 fathoms.

In the Moray Firth the numbers of plaice captured per hour by the otter trawl of the research vessels vary within very wide limits at the different localities and show the usual tendency to diminish as the depth increases. In pre-war years the numbers caught per hour were large in the shallow waters of Burghead Bay and Dornoch Firth, but dwindled rapidly to under two per hour in waters of over 30 fathoms, near the mouth of the Moray Firth. On the other hand, there was a steady increase in size towards the deeper waters and the larger fish some of which were 60 cm. and over formed five to seven per cent. of the relatively small numbers caught on the deeper grounds. It is characteristic of the Moray Firth that there is a winter maximum occurring between October and March. In other words it is during the breeding season that the larger fish chiefly resort to and concentrate within the area. It has been stated previously that spawning occurs from December to April (inclusive) and that with the exception of the shallow coastal belt spawning is of greatest intensity in depths of less than 30 fathoms. Vessels permitted to operate within this area during the spawning period therefore can take a greater toll of the stock than at other periods of the year. This statement applies to vessels using the Danish seine net as well as to non-British vessels using the otter trawl.

Many plaice marking experiments have been carried out in the Scottish area both in pre-war and in post-war years and it is of interest to ascertain the numbers of these which have been recaptured by the different types of fishing gear, more particularly with reference to the Moray Firth area.

Of the fish marked and liberated in this area a total of 987 were recaptured before 31st December, 1926, and of these, 109 (or approximately 11 per cent.) had migrated beyond the limits of the Firth. Those emigrants were adult fish and all were recaptured by trawl. Five of the records are doubtful and are omitted from consideration but of the others only 11 were caught at localities south of Rattray Head and 83 had migrated from the Firth in a northerly direction — 56 of the latter were taken on grounds to the North or West of Scotland; the remaining 27 fish were recaptured East of Orkney, at Fair Isle, or in Shetland waters. No immature fish left the Firth. Thus the adult fish, which migrate from the area, leave, as a rule, in a northerly direction.

The total number of marked fish recaptured within the precincts of the Firth by various types of fishing gear was 1206 and 328 of these immigrants which had been marked and liberated outside the area. The following are the monthly percentages of recapture of all fish retaken within the area:—

Marked Plaice.—Moray Firth.
Monthly Percentages of Recapture.

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
7.2	21.4	22.9	13.4	6.2	3.6	2.1	3.3	2.5	6.0	6.1	5.3

The pre-war and post-war recaptures are in substantial agreement as may be seen from the following analysis:—

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Pre-War Experiments	52.8	24.0	6.8	16.4
Post-War —	49.4	21.6	9.8	19.1

The small differences are due mainly to the fact that in the post-war experiments a much higher proportion of small fish was marked. Thus, approximately half of the fish were taken in the first quarter of the year.

If, however, a distinction is made between the non-migrant fish and the immigrants the following percentages are obtained for the four quarters of the year:—

Marked Plaice.

Percentages of Recapture in the Moray Firth.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Non-Migrants.....	46.6	24.1	9.3	20.0
Immigrants	64.6	20.8	4.3	10.3

The immigrants were adult fish most of which came from the grounds south of Rattray Head. These fish migrate most quickly during the period when the sexual organs are maturing and enter the Firth just before the spawning period. Most of the recaptures were made in the months December to March.

In view of the fact that the Danish seine net was not introduced into Scottish waters until September 1921, the pre-war experiments and post-war experiments are given separately, the results being condensed in the tables on page 230.

It should be noted that the pre-war and post-war experiments are not strictly comparable in view of the fact that the marking experiments were not carried out in a uniform manner at the different localities throughout the various years and that in the post-war experiments the greater proportion of the fish marked were under 30 cm. in length and were liberated in close proximity to the coast. Such fish so long as they remain within territorial waters are liable to capture only by small lines and set nets. The intensity of fishing by small lines in the post-war period is therefore not so high as it is represented to be by the percentages of recapture. Most of the fish captured by small lines are taken in the first and second quarters of the year, February, March and April being the chief months.

Cod nets, flounder nets and salmon nets are included under the term set nets as they are not always clearly distinguished from each other in the records. The cod nets are the most important, however, and most of the plaice included under the term set net were captured by these nets. Before the introduction of the Danish seine a number of the smaller boats chiefly from the Banff ports carried on a small fishery for flatfish by means of flounder nets set in the neighbourhood

Marked Plaice.
Recaptured in the Moray Firth.
Pre-War Experiments.

	Methods of Recapture				Total Recaptured	Percentages
	Line	Set Nets	Trawl	Not Specified		
1st Quarter	51	205	137	6	399	52.7
2nd —	20	15	145	2	182	24.1
3rd —	11	1	39	—	51	6.8
4th —	10	6	107	1	124	16.4
Total Recaptured	92	227	428	9	756	
Percentages	12.2	29.6	57.0	1.2		

Post-War Experiments.

	Methods of Recaptures				Total Recaptured	Percentages
	Line	Set Nets	Trawl	Seine Net		
1st Quarter	60	90	26	46	222	49.4
2nd —	34	15	22	27	98	21.6
3rd —	4	6	27	7	44	9.8
4th —	4	1	37	44	86	19.1
Total Recaptured	102	112	112	124	450	
Percentages	22.7	24.9	24.9	27.5		

of the coast in the early months of the year, but this method has now practically been abandoned. The capture of flatfish by cod nets is confined to the first four months of the year, the principal months being February and March. Over one fourth of all the marked plaice recaptured in the Moray Firth, both in the pre-war and post-war periods, were taken by this method of fishing.

Over one half of the marked fish were retaken by means of trawl and Danish seine net. Both in pre-war and in the post-war experiments a number of recaptures which may be described as "border line" fish have been included in the records. These are fish marked and liberated well within the Firth which are stated to have been recaptured just on the limit line. In the pre-war experiments there are forty-six such records but if these are excluded from consideration there are still over 50 per cent. of the marked fish recaptured by trawl. In the post-war experiments there are no "border line" fish in the records of fish caught by Danish seine net but there are 47 caught by trawl. In the post-war period the reduction in the

intensity of fishing by trawlers has been compensated by the activities of the Danish seine netters.

The plaice fishery of the northern North Sea is in a somewhat different category from that of the shallow southern North Sea. It is only in the neighbourhood of Aberdeen and for a limited period of the year (October to January) in favourable years that trawling involves the capture of a relatively large number of fish at a small size and for a trifling value per fish.

The effect of operations of the Danish seine net on the plaice population differs slightly from that of the otter trawl as is illustrated by the following example. The experiments were made in St. Andrews Bay in November 1923 where comparable hauls were made with the ordinary otter trawl with cod-end mesh of $3^1/_4$ to $3^1/_2$ inches and a Danish plaice seine with cod-end meshes of 3 to $3^1/_4$ inches, on the same grounds.

Plaice.

St. Andrews Bay: Novr., 1923.

Size in cm		11	12	13	14	15	16	17	18	19	20
Frequencies	Trawl	1	1	13	31	36	35	41	43	116	159
	Danish Seine	—	—	—	—	—	—	—	2	26	79
Size in cm		21	22	23	24	25	26	27	28	29	
Frequencies	Trawl	219	239	215	139	102	45	10	4	1	
	Danish Seine	115	242	230	217	108	49	18	11	3	

The experiments show that while the otter trawl catches the larger sizes of plaice in the same proportion as the Danish seine net it also catches considerable numbers of the smaller sizes which escape the Danish seine.

The following experiments were carried out in St. Andrews Bay in September 1924. This area was selected in view of the fact that the critical sizes of plaice for testing the effect of the net were present on the grounds in large numbers. In both nets the sizes of the cod-end meshes varied between 3 and $3^1/_4$ inches as measured diagonally from knot to knot.

The following are the size frequencies expressed cumulatively per 1000 fish caught by each apparatus.

Plaice.

St. Andrews Bay — September, 1924.

Number caught below any given size per 1000 fish caught.

Otter Trawl.

cm.	12	13	14	15	16	17	18	19	20	21
Frequencies	1	2	11	32	57	80	108	138	218	328
cm.	22	23	24	25	26	27	28	29	30	
Frequencies	479	644	792	888	958	989	996	999	1000	

Danish Seine Net.

cm.	12	13	14	15	16	17	18	19	20	21
Frequencies	—	—	—	—	—	—	—	2	24	90

cm.	22	23	24	25	26	27	28	29	30
Frequencies	269	471	663	644	934	974	989	998	1000

In the case of the Danish plaice seine half of the catch was between 22 and 24.5 cm. long, while the median size of the fish was between 23 and 24 cm. In the catch made by otter trawl half of the fish were between 20 and 24 cm. in length and the median size was at 22 cm.

Experiments with the otter trawl with a covering of small mesh showed that there were two distinct size or age groups in the area, representatives of which the Danish seine did not capture.

From these experiments it is evident that the smaller fish tend to escape through the wider meshes of the wings of the Danish seine as the net is being hauled.

Turning now to the haddock we find that a totally different condition of affairs exists. The predominant marketable species of the northern and deeper waters of the North Sea, it takes to the bottom at a relatively early age and remains a typical demersal fish for the remainder of its life, leaving the bottom only for very limited periods. As already stated, the distribution of the early bottom stages of the haddock is in striking contrast to that of the cod. The latter in the young stages very early seeks the sea weed and shallow coastal zone. Later in life, too, the haddock is a much more social fish than the cod and it is only during the spawning period that the adults of the two species may be compared in this respect. Further, at other periods of the year the cod makes more frequent excursions into the upper water layers.

The age at which a haddock becomes liable to capture by trawl depends on its rate of growth and the size of the cod-end meshes used. The trawl, a triangular bag dragged over the sea floor, may be divided into two sections — the collecting part and the retaining portion. The cod-end is the retaining part and has the smallest size of mesh. It is guarded at its upper end by a trap or "flapper". All fish, therefore, which enter the mouth of the net and are carried down the collecting portion past the "flapper" into the cod-end of the net escape through the meshes there only if small enough.

A large number of experiments have been performed to ascertain how many and what sizes of fish of different species are likely to escape through a definite size of cod-end mesh under normal fishing conditions. The following are the results of experiments carried out under such conditions with an otter trawl having a cod-end mesh of size similar to that generally used (3—$3^1/_4$ inch mesh). The cod-end of the trawl was enveloped by a light net of much smaller mesh so that the

fish which escaped through the cod-end meshes of the ordinary trawl were retained in this outer covering net. These figures have been represented on the accompanying graph by calculating the percentages of fish which escape at each size:—

Haddock:

Percentage of Escape at each Size from Cod-end with 3-3$^1/_4$ inch mesh.

Size in cm.	6	7	8	9	10	11	12	13	14	15	16	17
No. of fish in cod-end...	—	—	—	—	—	—	7	5	6	99	230	539
No. of fish in outer covering	14	89	135	136	128	157	231	428	1186	1977	2457	4070
Percentage at each size which escaped	—	—	—	—	—	—	—	—	99.5	95.23	91.4	88.3

Size in cm.	18	19	20	21	22	23	24	25	26	27	Beyond 27
No. of fish in cod-end....	2025	4822	8755	7908	8663	8477	8576	6185	6407	7161	—
No. of fish in outer covering	7244	11099	10527	4519	1939	527	205	82	62	29	Nil.
Percentage at each size which escaped	78.10	69.72	54.59	36.36	18.28	5.85	2.33	1.31	.95	—	Nil.

Although experiments with commercial apparatus, such as the ordinary otter trawl, cannot be expected to yield results of the same degree of accuracy as experiments carried out under more rigorous conditions, the results are such as to show that under normal fishing conditions there is a law regulating the size of escape through the cod-end meshes. There is a size beyond which no fish can escape and there is a size below which all fish may escape and between these two extremes there are the appropriate gradations. The sizes between these two extremes may be termed the critical sizes for that particular size of mesh.

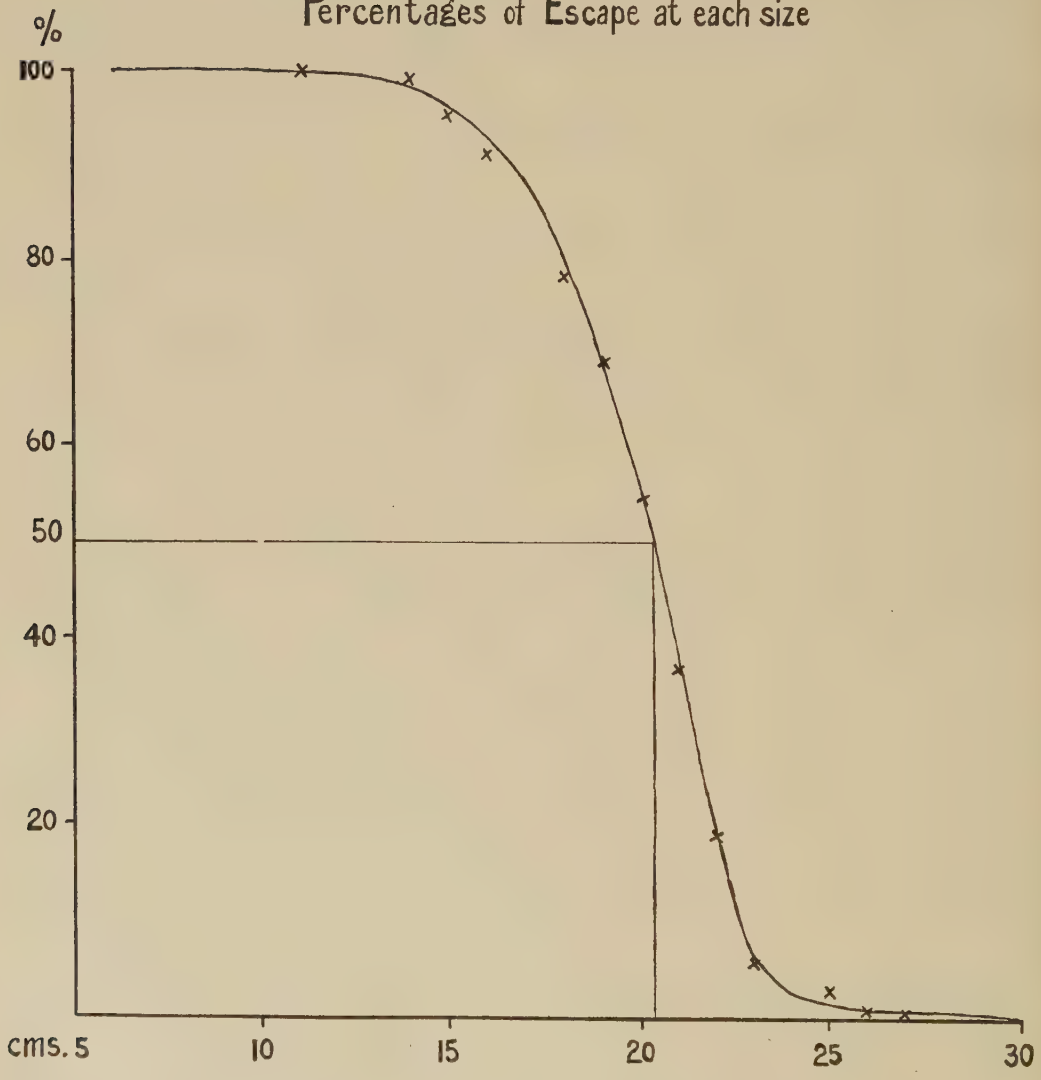
In a series of experiments carried out under similar conditions with a larger cod-end mesh, the same type of results was obtained, but the graph was shifted to the right; in other words, an increase in the size of the mesh allowed of a greater number of fish of larger size to escape. A similar series of graphs of the same general type was obtained for other species, both round and flatfish. Any increase in the size of the mesh permits of a corresponding increase in the number of escapes of larger fish and *vice versa.*

The following are the results of a series of experiments, made on the same grounds on the same date, with different sizes of cod-end meshes in which the cod-end, however, was not enveloped with a covering net of smaller mesh. Three sizes of cod-end meshes were used in the experiments, the diagonal measurement

HADDOCK

OTTER TRAWL: 3-3¼ inch mesh cod-end

Percentages of Escape at each size



of the meshes being Number 1, $2^1/_4$—$2^1/_2$ inches, No. 2, 3—$3^1/_4$ inches and No. 3, 3—$3^1/_2$ inches respectively.

In the first place, a series of experiments was made with the smallest cod-end mesh with a covering net to retain very small fish, to ascertain whether haddock of the smallest sizes were present on the grounds in sufficient numbers to test the action of the meshes at the critical sizes. The smallest haddock captured by No. 1 cod-end was 17 cm.; by No. 2 cod-end 19 cm. and by No. 3, 20 cm.

Without detailing the various experiments, the effect of the different sizes of mesh on the haddock population under the conditions may perhaps best be described by considering the capture of haddock of 12 inches (30 cm.) and under. For every 1000 haddock between the sizes of 10 and 12 inches captured with No. 1 cod-end, 2226 haddock less than 10 inches (25 cm.) were also taken, for No. 2 cod-end 754 under 10 inches and No. 3 cod-end 290. Thus a small increase in the size of the cod-end meshes permitted the escape of large numbers of small haddock under 10 inches in length.

Returning to the graph, however, it will be seen that between the critical sizes the graph is practically symmetrical about the 50 per cent. line. In other words, between the two extremes as many fish escape above as are captured below this critical size. This point may be termed the critical point for the particular species under the given conditions, since between the critical sizes the percentages of escapes and captures are nearly evenly balanced. With a cod-end mesh of 3—$3^1/_4$ inches and fishing under normal conditions, haddock are liable to be caught when they reach an average size of approximately 20 cm. It has already been seen that the haddock of the North Sea reaches an average size of 17 cm. by the end of its first year of life and that the individuals of the same age range from 11—23 cm. in length. Hence, even in the first year a small proportion of the more rapid growers are liable to capture by the trawl. But the age of haddock of 20 cm. is approximately 15 months and it is just after the month of July that haddock in their second year begin to appear in numbers in the catches of the trawlers fishing on the small haddock grounds. This phenomenon is well marked after a good brood year.

The following extracts from the records of the research vessel fishing off the Aberdeenshire Coast in July, August and September 1921 are of considerable interest and importance comparable, as they are, with the catches of the trawlers working on the near grounds and landing their catches at Aberdeen.

During the course of the experiments from 20th July to 10th August 1925 a total of 23,306 haddocks was caught for 21 hours 10 minutes trawling or approximately 11,000 fish for ten hours' daylight fishing. The sizes ranged from 16 cm. to 56 cm. and the following table gives the frequencies per 1000 fish caught and the number caught less than any given size per 1000 fish caught:—

20th July—10th August.

Size in cm.	16	17	18	19	20	21	22	23	24	25	26
Frequencies	2	10	24	138	114	255	191	89	43	27	23
Summation	2	12	36	174	288	543	734	823	866	893	916

Size in cm.	27	28	29	30	31	32	33	34	35	36—56
Frequencies	20	17	15	10	9	6	2	1	2	2
Summation	936	953	968	978	987	993	995	997	998	1000

The median is approximately 20.6 cm. and half of the total number of fish caught were between 19.7 cm. and 22.1 cm. or, say, approximately between $7^3/_4$ and $8^3/_4$ inches.

Thus for every 1000 haddock caught only 134 were over 24 cm. in length.

The following are the figures for the first week of September:—

Size in cm.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	33—43
Frequencies	2	11	82	249	285	214	89	42	12	5	3	2	1	1	2
Summation	2	13	95	344	629	843	932	974	986	991	994	996	997	998	1000

Twenty-three thousand five hundred and fifty-five haddocks were obtained in nine hours ten minutes' trawling or about 25,700 per ten hours' daylight fishing. The median is now 21.6 cm., the increase being due to the growth of the small haddocks in the interval of about one month. Half of the haddocks caught lay between 20.7 and 22.5 cm. in length or, say, between 8 and 9 inches long. In other words, less than one quarter of the haddocks caught were over 9 inches in length (and 9 inches is a very small haddock for market purposes).

Any increase in the size of the mesh to allow larger haddock to escape is equally effective for other species. It has been asserted, however, that under such conditions the numbers of small unmarketable species such as long rough dabs etc., which are at present captured, would escape and increase to such an extent that they would become serious competitors with the haddock for the available food supply. It may be pointed out, however, that the present size of mesh begins to eliminate the haddock after it has reached an average size of 20 cm. and that since the haddock does not reach maturity until it has attained an average size of about 28 cm. it is theoretically possible to fish out the species by an increased intensity of fishing. On the other hand, the long rough dabs reach maturity at a size considerably below the size first captured by a net with a 3—$3^1/_4$ inch cod-end mesh and hence it would not be possible to fish out the species with this type of gear. Any increase in the size of mesh is therefore more favourable to those species which mature at a relatively large size and would further tend to allow of a greater number spawning at least once.

The action of the Danish seine net on the haddock stock is similar to that of the trawl. The net, however, is constructed of much lighter material and is dragged more slowly over the bottom.

The following are comparable data of catches of haddock made by Danish seine net and otter trawl in the Moray Firth area in October and November 1921. The fish caught by Danish seine net were measured on board the Danish seine net vessels working in the Firth, while the fish caught by otter trawl were taken by the research vessel.

Moray Firth.
October—November, 1921.
Danish Seine Net.
Haddock.
No. of fish caught below any given size per 1000 fish caught.

Size in cm.	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Summation	1	1	3	10	24	42	73	119	174	228	284	331	392	432
Size in cm.	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Summation	521	584	644	719	789	840	814	898	911	924	938	947	957	962
Size in cm.	49	50	51	52	53	54	55	56	57	58	59	60	61	
Summation	971	975	981	982	985	989	994	996	998	999	999	999	1000	

Otter Trawl (Granton Pattern).

Size in cm.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Summation	1	2	2	3	5	14	50	100	247	378	595	667	734	775	796	828	864
Size in cm.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	....	63
Summation	885	913	931	946	960	967	976	981	985	988	991	992	994	996	996		1000

The median for the Danish seine net catches is approximately 35 cm., while that for the otter trawl is almost 10 cm. less. Half of the catch of the Danish seine net lies between 30 and 39 cm. in length, while the half of the catch of the trawl lies between 24 and 29 cm. A considerable number of the small haddocks are able to escape through the ballooned meshes of the wings or collecting portion of the Danish seine net before they are carried down into the cod-end with its smaller meshes. The speed with which the otter trawl is dragged over the bottom is a factor which has to be considered in relation to the sizes of escapes.

Within recent years there has been introduced into the fishery a patent trawl (The Vigneron-Dahl Gear) for which there is claimed increased efficiency.

As this apparatus or some modification thereof has been widely adopted it is of considerable importance to ascertain its qualitative effect on the fish stocks. It is claimed that increased efficiency is obtained by the introduction of ground cables (50 fathoms in length, or less), between the otter boards and the net. This permits of a wider spread of the boards and as the headline of the trawl is not attached to the boards there is less strain on it and it can therefore be raised to a higher level above the sea floor, by the use of glass floats along its length. It

is also claimed that the ground cables by stirring up the bottom create a cloud of mud so that fish disturbed by them are less likely to escape the trawl.

In the months of February, March and April 1926 comparable experiments on the same grounds in the neighbourhood of Aberdeen were carried out with the Vigneron-Dahl Gear (Number Va) and the ordinary commercial otter trawl (Granton Pattern) in use on the research vessel "Explorer". Special attention was paid to the sizes of the cod-end meshes used.

Two series of experiments were made, one in deep and one in shallow water, the total duration of the experimental hauls in each case being 10 hours.

All the fish captured during the experiments were measured to the nearest centimetre with a view to ascertaining the action of the meshes on the various sizes of fish. The cod-end meshes of the Vigneron-Dahl net were slightly less than those of the otter trawl, there being 30 rounds to the yard as against 28 for the otter trawl.

The following are the data for the total haddocks caught by both gears reduced to size frequencies per thousand fish caught.

Size in cm. ...	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Frequencies:—														
V. D. Trawl .	—	4	11	29	33	29	81	153	156	98	60	71	63	65
Otter Trawl.	2	3	13	23	30	55	77	168	167	101	73	61	51	46

Size in cm. ...	29	30	31	32	33	34	35	36	37	38	39	40	50
Frequencies:—													
V. D. Trawl .	36	27	21	17	8	8	8	3	5	3	2	1	6
Otter Trawl.	33	29	18	15	12	4	7	2	3	1	1	3	3

It will be noted that per 1000 fish captured the distributions of sizes are very similar for both nets and do not differ more than one might expect in random sampling. In other words, there is no very distinct selective action by the Vigneron-Dahl net with a similar size of mesh in the cod-end.

The introduction of more powerful gear having cod-end meshes similar in size to those used in the ordinary commercial otter trawl calls for attention. While such gear will be more effective for the capture of fishes of marketable size it will also be more destructive of those just below market size and will thus have the same effect on the stock as an increase in the number of vessels using the ordinary trawl.

Correction.

p. 108, l. 26. 4627 should read 4637.